A dissertation on

DOPPLER STUDY ON UTERINE AND UMBLICAL ARTERY TO PREDICT PREECLAMPSIA AND IUGR

Dissertation submitted in partial fulfillment of

regulation for the award of

M.S. DEGREE IN OBSTETRICS AND GYNAECOLOGY

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
Chennai – 600 032.
APRIL-2014

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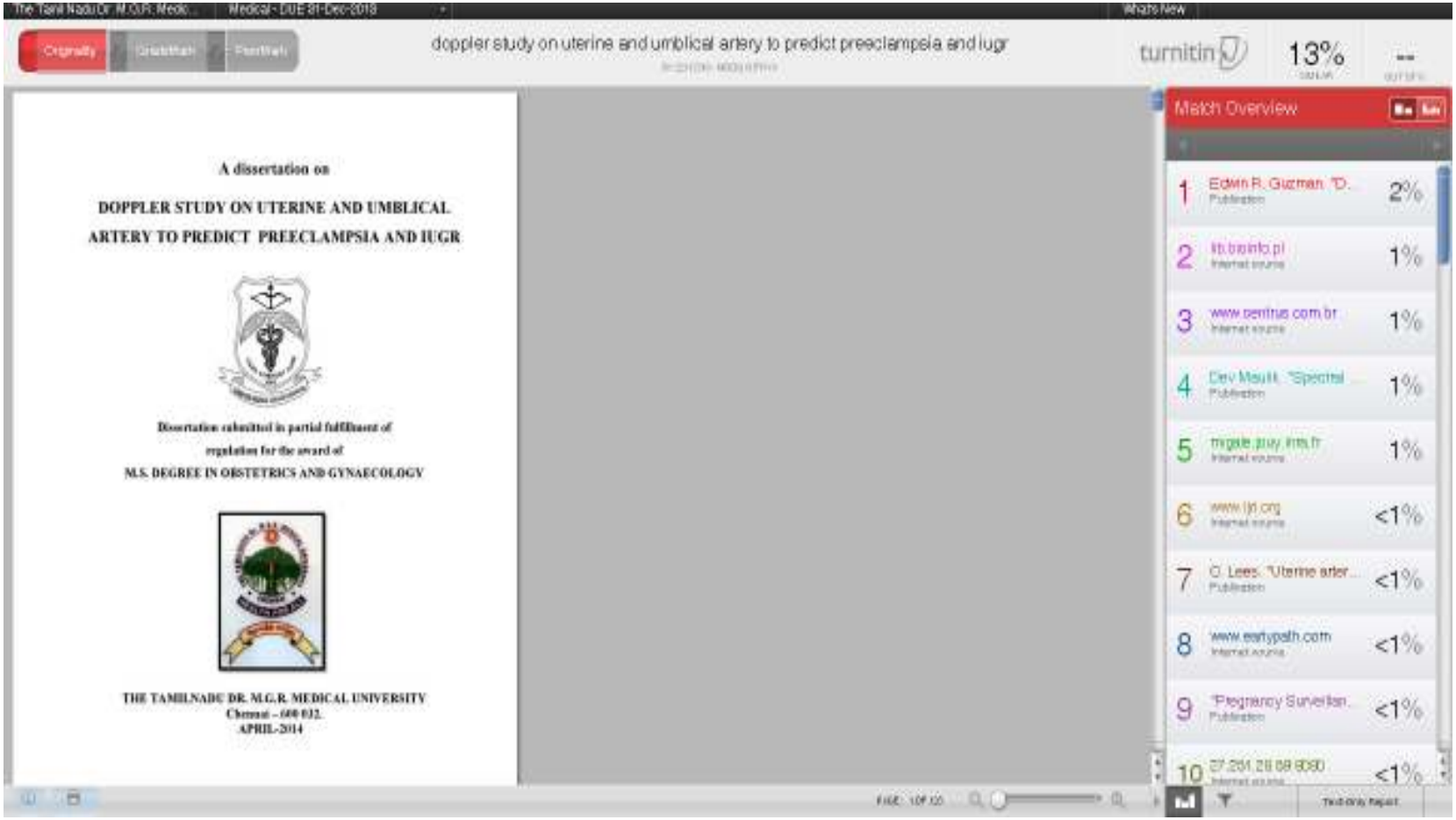
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LIST OF ABBREVIATIONS

AEDF	-	Absent end diastolic Flow
CMCH	-	Coimbatore Medical College
ED notch	-	Early diastolic notch
FVW	-	Flow velocity Waveform
FGR	-	Fetal Growth Restriction
IUGR	-	Intra Uterine Growth Restriction
LMP	-	Last Menstrual Period
LSCS	-	Lower Segment Caesarian Section
NICU	-	Neonatal intensive care unit
NPV	-	Negative Predictive value
NVD	-	Normal vaginal Delivery
PPV	-	Positive Predictive Value
RI	-	Resistance Index
S/D	-	Systolic/ Diastolic ratio
SES	-	Socio Economic Status

ABSTRACT

DOPPLER STUDY ON UTERINE AND UMBLICAL ARTERY TO PREDICT PRE ECLAMPSIA AND IUGR

In pre eclampsia and IUGR the uteroplacental and fetoplacental perfusion decreases due to increased vascular resistance. The uteroplacental and fetoplacental perfusion can be studied non-invasively by means of Doppler ultrasound. Pre eclampsia and IUGR are the most important cause for maternal and perinatal morbidity and mortality. It is necessary to predict preeclampsia and IUGR to decrease the incidence and adverse outcomes of the both.

- To asses Doppler data finding in predicting adverse pregnancy outcome like Pre eclampsia and IUGR.
- To find whether an association exists between pre eclampsia and IUGR in second trimester Doppler of uterine and umblical artery.
- To determine whether Doppler of uterine and umblical artery at 26-30 wks of gestation age can be predictor of pre eclampsia and IUGR.

METHODS

105 women with singleton pregnancy between 26 to 30 weeks of gestation were studied in this prospective study over a period of one year with colour Doppler. Uterine and umbilical artery flow velocity form were studied. In both uterine and umbilical artery S/D ratio and RI were studied. In uterine artery presence or absence of early diastolic notch is noted. In umblical artery absent diastolic flow or reversed diastolic flow is noted.

RESULTS

100 patients were taken for analysis as five patients were excluded from the study. Out of 100 patients, 7 patients developed preeclampsia, 13 patients developed IUGR. Uterine artery Doppler was abnormal in 17 patients. In that 6 patients had pre eclampsia and 7 patients had IUGR. With sensitivity of 86% and specificity of 90% for pre eclampsia and 54% and 90% for IUGR. In Umbilical artery Doppler was abnormal in 12 patients 10 patients developed pre eclampsia and 4 developed IUGR with sensitivity and specificity of 43% and 93% for preeclampsia, 70% and 99% for IUGR. One patient had AEDF, 1 patient had REDF both patients developed Pre eclampsia and IUGR giving the sensitivity and specificity of 100% for Pre eclampsia and IUGR.

INTERPRETATION AND CONCLUSION

Both uterine and umbilical artery flow velocity waveforms abnormality is more predictive for preeclampsia and IUGR. Early diastolic notch in uterine artery has a predictive value of 37% for preeclampsia and 50% for IUGR. Hence Doppler is a promising tools in prediction of Pre eclampsia and IUGR.

KEYWORDS

Pre eclampsia; IUGR; Uterine artery; Umblical artery; Early diastolic notch; AEDF-Absent endiastolic flow; REDF – Reverse end diastolic Flow

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INTRODUCTION

INTRODUCTION

Pre-eclampsia is the most important reason for maternal and fetal mortality. It affects 2-5% of pregnancies and is principally disease of first term pregnancy[1]. Pre eclampsia is due to reduced organ perfusion due to vasospasm and endothelial damage. Almost all the morbidity being due to multisystemic manifestations in many organs including brain, liver, kidney and placenta. IUGR is a complication of pre-eclampsia and is due to failure of normal placental invasion and development. The primary pathology is the impairment of placental perfusion, which may be attributed to abnormal placentation of maternal vascular disease. Impaired placental perfusion is believed to result from insufficient invasion of maternal spiral arterioles by the trophoblast early in gestation. Consequently, the crucial hemodynamic changes seen in normal pregnant uterine vasculature – that is shift from low volume high resistance to high volume low resistance environment does not take place[2]. This leads to increased vascular resistance and decreased uteroplacental perfusion. The subsequent placental ischemia may lead to production of free radicals damaging the endothelial cells. The main goals of antepartum fetal surveillance are to identify fetuses at increased risk for perinatal mortality and morbidity. Doppler ultrasound allows a noninvasive assessment of fetal haemodynamics [3, 4]. umblical arteries doppler provides information about perfusion of the fetoplacental circulation, Umblical artery (UA) Doppler velocimetry is the important evaluated test among the noninvasive tests of fetal

wellbeing[5]. Several authors have reported a low end diastolic velocity in the umblical artery, a consequence of high flow resistance in capillaries of the terminal villi.

The association between abnormal umblical artery Doppler velocimetry and adverse pregnancy outcomes has been investigated widely[6,7]many reports have shown a statistically relation between increased fetoplacental resistance,as estimated by either the resistance index or (S/D), and the later development of either preeclampsia or fetal growth retardation (FGR)[8,9]. Despite these statistically significant correlations, the clinical utility of umblical artery Doppler studies has been questioned because of its low predictive values for either preeclampsia or FGR and other[10,11] adverse outcome in low risk population.

Hence it is necessary to study uterine and umblical artery Doppler velocimetry in Preeclampsia and IUGR.

AIMS AND OBJECTIVES

AIMS OF THE STUDY

- To asses Doppler data finding in adverse pregnancy outcome like Pre eclampsia and IUGR.
- To find whether an association exists between pre eclampsia and IUGR in second trimester Doppler of uterine and umblical artery.
- To determine whether Doppler of uterine and umblical artery at 26-30 wks of gestation age can be predictor of pre eclampsia and IUGR.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Doppler waveform analysis and Doppler indices: The maximum Doppler frequency shift waveform represents the temporal changes in the peak velocity of the red cell movement during the cardiac cycle. It is therefore under the influence of both upstream and down stream circulatory factors.[12] The objective has been to obtain information specifically related to distal circulatory homodynamic. Techniques have been developed foe analyzing this waveform in an angle independent manner. Most of these analytic techniques involve deriving Doppler indices or ratios from the various combination of the peak systolic, end diastolic, and temporal mean values of the maximum frequency shift envelope. Because these parameters are taken from the same cardiac cycle, these ratios are virtually independent of the angle of insonation. A unique characteristics of uteroplacental, fetoplacental and cerebral circulation in the fetus is the continuting forward flow during diastole. This feature develops progressively in fetoplacental circulation so that the perfusion of vital organs is uninterrupted throughout the cardiac cycle. The essential effect of this phenomenon includes not only the progressive increase in the end diastolic component of the flow velocity but also a concomitant decrease in the pulsatality, which is the difference between the maximum systole and the end diastolic components. The pulsatility of the flow velocity was originally investigated using Doppler ultra sound in the peripheral vascular system.

The blood flow characteristic can be quantified by various Doppler indices like the systolic/diastolic ratio (s/d), resistance indes (RI) and the pulsatility index (PI), which can be taken on any vessel.[13,14]

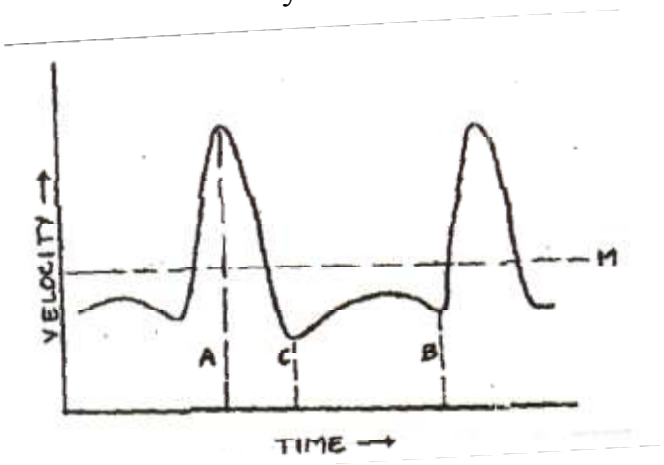


Figure: 1 The typical waveform of blood flow

The indices are:[13,14]

1. S/D ratio i.e: Peak Systolic Velocity = A
   End diastolic Velocity B

2. Resistance Index (RI) i.e Peak Systolic- End Diastolic = A-B
   Peak Systolic Velocity A

3. Pulsatility Index (PI) i.e Peak Systolic Diastolic Velocity = A-B
   Mean Velocity M

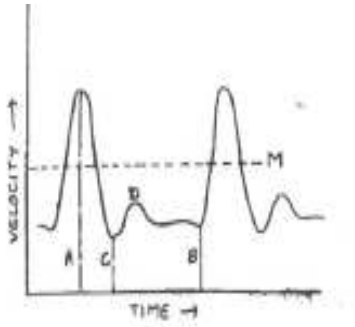


Figure : 2 The waveform with a notch (D)

S/D ratio gives a simple evaluation of blood flow during diastole and provides estimation of down stream resistance.[15] The pourcelot index or RI is useful when the diastolic flow is absent or reversed and S/D cannot be calculated.[16] Hence, it helps in comparing any waveform irrespective of its diastolic flow.

The pulsatality index considers the mean velocity as diameter i.e, the whole of the flow is given consideration not just the diastolic flow and hence can be used to analyse data from various vessels without encountering the excessive variation that can be caused by division by small numbers as with the other two indices.[15]

PATHOPHYSIOLOGY OF PRE-ECLAMPSIA AND FETAL GROWTH RESTRICTION[17]

DEFINITION

Pre-eclampsia is a pregnancy specific syndrome of reduced organ perfusion secondary to vasospam and endothelial activation. Minimum criteria for pre-eclampsia are:[15]

1. BP140/90mm Hg after 20 weeks gestation
2. Proteinuria 300mg/24 hours or 1 + dipstick

Fetal growth restriction can be broadly defined as an intrauterine fetal growth, which results in the birth of an infant weighing less than its genetic potential.[15,17] To recognize this, various definitions of low birth weight based on percentiles of weight have been proposed for e.g.

1. < 10^{th} percentile by Battaglia Lubchenco 1991[18].
2. < 5^{th} percentile by seeds, 1984.[19]

The syndrome complexes of pre-eclampsia and fetal growth restriction have similar pathology of placental insufficiency. Here the blood supply to the fetus is inadequate because of defective placentation, which can be part of syndrome of pre-eclampsia or can individually lead to defective growth of the baby i.e small for gestational age baby.

Hypertensive disorders complicate 5-10 % of all pregnancies and they form a traid along with, Hemorrhage (Antepartum, postpartum) & sepsis. All

these three together form a major portion of maternal mortality rate world wide.

Pre-eclampsia is identified in 3.9% of all pregnancies[20]. In developed countries, maternal mortality rate due to hypertensive disorders is 16%[21]. This percentage is greater than other three leadingcauses: Hemorrhage – 13%, Abortion – 8%, Sepsis – 2%

DEFINITION

According to National High Blood Pressure Eduction Program (NHBPEP) 2000 & ACOG (2002).

Hypertension is defined as diastolic BP of ≥90 mmHg and systolic BP of ≥ 140mmHg after 20 weeks of gestation in a previously normotensive women. Measurements should be confirmed by repeated readings over 4-6 hours.

Severe Hypertension in pregnancy is defined as

- Systolic BP greater than or equal to 160 mmHg and /or
- Diastolic BP greater than or equal to 110mmHg.

This represents a cut off level of BP beyond which cerebral autoregulation stops functioning leading cerebral haemorrhage and hypertensive encephalopathy.

CLASSIFICATION OF HYPERTENSIVE DISORDERS IN PREGNANCY

According to NHBPEP

1. GESTATIONAL HYPERTENSION

Systolic BP ≥ 140 or diastolic BP ≥ 90 mmHg for the first time during pregnancy.

- No proteinuria
- BP returns to normal before 12 weeks post partum.
- May have imminent signs and symptoms of pre-eclampsia, like blurring of vision, headache

2. PRE ECLAMPSIA

Diagnosed when there is

- BP ≥ 140/90 mmHg after 20 weeks of gestation.
- Proteinuria ≥300 mg/24 hours or ≥ 1 + dipstick

SEVERE PRE ECLAMPSIA

- Bp ≥ 160/110 mmHg for the first time during pregnancy.
- Proteinuria 2.0 g/24 hours or ≥ 2 + dipstick
- Serum creatinine > 1.2 mg/dl unless known to be previously elevated.
- Platelets < 1,00,000/ cu mm
- Microangiopathic hemolysis
- Elevated serum transminase levels – ALT or AST
- Severe headache, blurring of vision, vomiting

- Persistant discomfort in epigastric region
- Pulmonary edema
- Oliguria < 500ml/24 hrs
- Fetal growth restriction

3. ECLAMPSIA

Generalised tonic clonic seizures occurring in an antenatal women with which cannot be contributed to other causes like epileptic, hypoglycaemic attacks.

4. SUPERIMPOSED PRE-ECLAMPSIA ON CHRONIC HYPERTENSION

- New onset proteinuria ≥ 300 mg/24 hours in hypertensive women but no proteinuria before 20 weeks gestation
- A sudden increase in proteinuria or blood pressure or platelet count < 1,00,000/microlitre in women with chronic hypertension.

5. CHRONIC HYPERTENSION

- Bp ≥ 140/90 mmHg before conception or identified before 20 weeks gestation not including gestational trophoblastic disease, twin gestation (or)
- Hypertension first identified after 20 weeks gestation and persisting even after 12 weeks postpartum.

PROTEINURIA :-

It can be expressed as excretion of 300 mg/24 hrs urine or a urine protein/creatinine ratio of 30 mg/mmol or, urine dipstick ≥ 1 + on dipstick or more in at least two random urine samples collected at least 4 to 6 hours apart[22]. Urinary tract infection should be excluded. This dipstick testing for proteinuria can be used as a Preeclampsia test. But the test has very high false positive and more important false negative rates[23].

Anatomy of fetoplacental and uteroplacental circulation

Fetoplacental circulation[24,25]

In fetal life oxygenation is carried out in the placenta. The fetal surface of the placenta is covered by the transparent amnion, beneath which the fetal chorionic vessels course.

Deoxygenated fetal blood flows to the placenta through the two umblical arteries. When the umblical cord joins the placenta, the umblical vessels are branched repeatedly beneath the amnion and again within the dividing villi, finally forming capillary networks in the terminal divisions. Blood with significantly higher oxygen content returns from the placenta to the fetus through a single umblical vein.

The branches of the umblical vessels that traverse along the foetal surface of the placenta in the chorionic plate are referred to as the placental surface or chorionic vessels. These vessels are responsive to vasoactive substances, but anatomically morphologically, histologically, and functionally, they are unique. The chorionic arteries always cross over the chorionic veins. Identification of chorionic artery and vein is most readily recognized by this interesting relationship, but they are difficult to distinguish by histological criteria. In 65 percent of placentas, the chorionic arteries form a fine network supplying the cotyledons .The remaining 35 percent of arteries radiate to the

edge of the placenta without narrowing. Both are end arteries, supplying one cotyledon as each branch turns downward to pierce the chorionic plate.

The truncal arteries are the perforating branches of the surface arteries that pass through the chorionic plate. Each truncal artery supplies one cotyledon. There is a decrease in the smooth muscle of the vessel wall and an increase in the calibre of the vessel as it penetrates through the chorionic plate. The loss in smooth muscle continues as the truncal arteries branch into the rami, and the same is true of the vein walls.

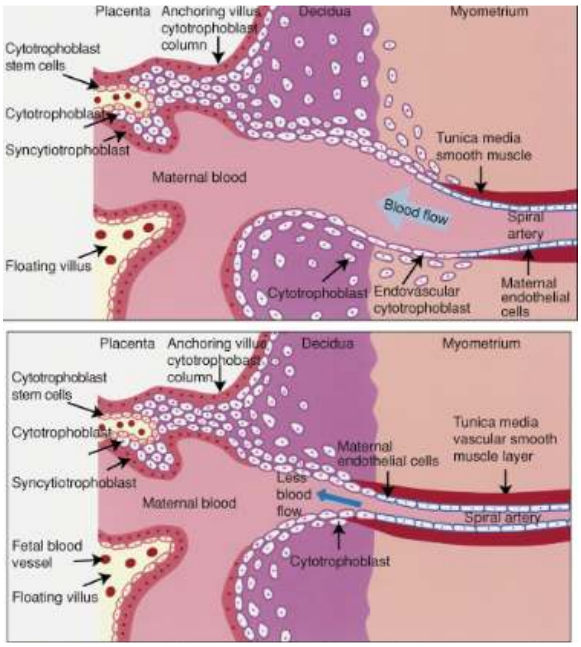
Abnormal development of uteroplacental circulation in the presence of preeclampsia and IUGR

According to Brosen et al[26], Robertson et al[27] and Khong et al[28] a lack of endovascular infiltration by trophoblast into the myometrial portion of the placental bed spiral arteries is a consistent finding in the presence of preeclampsia and IUGR. Classically it is held that second wave of endovascular trophoblastic invasion that proceeds in myometrial segments of the spiral arteries from about 15 weeks, does not occur in patients who will develop fetal growth restriction or pre-eclampsia. Lack of physiological is not only apparent in the myometrial segments of spiral arteries, but also in the decidual parts of some of the vessels, so that a proportion of spiral arteries completely fail to undergo trophoblastic invasion and physiological changes. Since unconverted vessels retain ‘high resistance / low capacitance properties,

the effect on maternal blood supply to the placenta may be dramatically low. These may manifest as impaired growth of the baby or high BP with proteinuria i.e pre-eclampsia with its complications.

The persistence of high resistance to flow after 24-26 weeks of gestation provides the rationale to investigate the placental circulation by Doppler and to predict development of pre-eclampsia and fetal growth restriction.

Normal



Preeclampsia

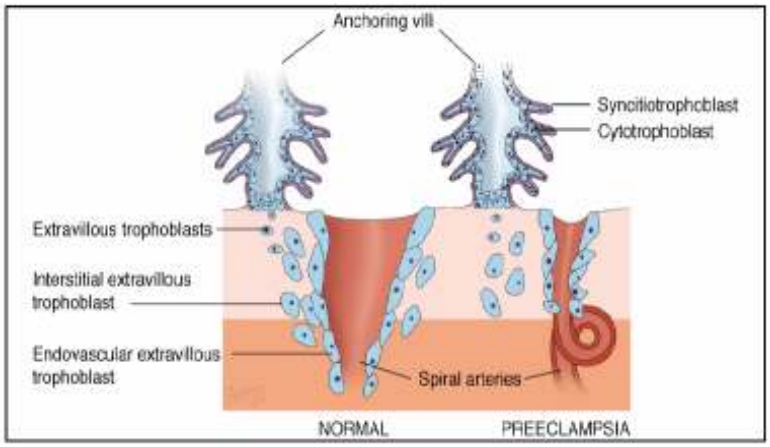


Fig 3: Normal and Preeclampsia changes seen in spiral arteries

Uteroplacental Circulation – Physiological Changes During Pregnancy[29]

Non-pregnant uterus

Characteristics shape of these waveforms shows a steep systolic slope, an early diastolic notch and a small diastolic flow. The waveform remains essentially high resistance although the waveform changes in the menstrual cycle with more flow in the luteal phase.

Uterine artery impedance varies according to the phase of ovarian cycle. Kurjak et al.1993[30] observed in 150 women that average RI (Resistance Index) during the proliferative phase was 0.88+/-0.04 (2SD). The RI starts to drop one day prior to ovulation reached a nadir of 0.84+/-0.04(2SD) on day 18 and remained at this level for remainer of the cycle.

Pregnancy changes was described by Campbell et al., 1983.[31] As pregnancy evolves, the diastolic phase augments, the gradient of the deceleration phase reducers, and the notch disappears in the first term in 27% of pregnancies, although its disappearance is sometimes not simultaneous in both uterine arteries.

Flow changes in the uterine arteries are expressed as modification in Doppler indices. At the onset of pregnancy, these indices show few differences compared with their values in the absence of pregnancy. From the 12^{th} – 26^{th} weeks of pregnancy there is a progressive lowering of these indices. In addition, the indices are lower in the artery homolateral to the implantation site. The difference between the arteries is more evident from the 8^{th} week and

they disappear after the 24th week. The findings are clearly related to the histological changes in the spiral arteries caused by the trophoblastic invasion of these vessels.

There is a gradual disappearance of notch.20% of these patients retain notch by 20 weeks and > 9% by 24 weeks. Hence, by 24-26 weeks, notch disappears and so does the differences between S/D ratio of placental and non-placental sites.

I am choosing uterine artery Doppler from 26th week gestation to reduce the false positive rate. Because the early diastolic notch can persist in some normal woman until 26th week of pregnancy (Fleischer et al., 1986).

Uterine artery Doppler in normal pregnancy

Uterine artery flow velocity waveform recorded in an early pregnancy have the diastolic notch which represents increased impedance to blood flow during early diastole in normal pregnancy. The early diastolic notch persist until approximately 26 weeks of gestations during which second wave of trophoblastic invasion would have completed resulting in vessels of minimal resistant, no elastic property and vigorous diastolic flow. Persistence of notch indicates severe with a significantly increased rate of fetal growth retardation.

Uterine Artery in Preeclampsia Patient

Impedance to blood flow in the uterine artery may increase in pregnancy complicated by hypertension as shown by Fleschier et al when uterine artery S/D ratio more than 2.6 during third trimester the birth weight at delivery was

lower than normal. Impaired uterine artery flow velocity can be identified by persistent abnormal index, persistent notch and significant difference between the indices in the two vessels. It was demonstrated when the difference between right and left uterine artery S/D ratio is more than one the incidence of adverse fetal outcome is high. Difference right and left artery S/D ratio is probably due to unilateral placentation. Uterine artery blood flow reflects hemodynamic changes that occur at the maternal side of the placenta[32]. These physiologic changes of the placental bed spiral arteries extend only to the deciduo-myometrial junction. In preeclampsia the spiral arteries may remain unconverted throughout their decidual and myometrial length. Another placental bed lesion seen with preeclampsia is an acute arteriopathy, termed acute atherosis. These lesions are seen in the decidual and myometrial segments of the placental bed spiral arteries, which have not undergone physiologic changes. The breadth and the severity of the lesion correlates with the severity and the duration of hypertension[33]. The umblical arteries are not innervated, beyond the proximal 1-2 cm of the umblical cord. Acute hypoxemia does not change the magnitude of umblical placental blood flow, suggesting that hypoxemia has little or no direct effect on the umblical - placental circulation[34].

The Characteristics of Individual Waveforms:

Uterine Arteries:

Uterine artery blood reflects hemodynamic changes that occur on the maternal side of the placenta[35]. Pregnancy results in marked changes in the uterine artery waveform. The resistance to blood flow in both uterine arteries decrease gradually from early pregnancy until the end of the second trimester. Hence, the systolic diastolic values do not change from 28th week.

Indices of Uterine Artery Waveform Analysis:

Uterine artery Doppler waveforms are most commonly analyzed by simple semi quantitative techniques. They are based on maximum Doppler shift frequencies, which vary during the cardiac cycle. Evaluation of the change in maximal Doppler shift over time provides information on the impedance of the circulatory bed.

1. **S/D Ratio or A/B Ratio**: Peak systole divided by end diastole. S/D ratio showed a gradual decrease from a mean of 2.6 at 28 weeks to 1.6 at 40 weeks gestation.

2. **Pulsatility Index (PI)**: which is the most complex of the three. It is calculated by peak systole minus end-diastole divided by mean value of the area under the curve over one cardiac cycle (S-D/mean velocity). It requires a computer program that calculates the area under the curve.

3. **Resistance index (RI) or Pourcelot Ratio**: Peak systole minus end diastole divided by peak systole (S-D/S). Impedance to blood flow in the uterine arteries may increase in pregnancies complicated by hypertension[36,37]. The increase in flow resistance within the uterine arteries results in an abnormal waveform pattern which is represented by either an increase RI or PI or by the presence of unilateral or bilateral diastolic notch[38]. As shown by Fleischer et al[39] (1986), when the uterine artery systolic/ diastolic (S/D) ratio was >2.6 during the third trimester, the birth weight at delivery was lower than normal and the incidence of fetal distress (low Apgar score and still birth) higher. Therefore increased uterine resistance in hypertensive pregnant women should indicate that the fetus is significantly compromised.

Table 1: Normal values of S/D ratio and RI in uterine artery Doppler

S. No.	Doppler Indicies	Normal	Abnormal
1	S/D Ratio	< 2.6	>2.6
2	RI	<0.56	>0.56

Uterine Artery Waveform Notch:

The uterine artery Doppler waveform has an early diastolic notch in the nonpregnant state. It also persists in the pregnant state until 20-28 weeks of gestation[40]. Presence of a notch is a significantly better predictor of poor pregnancy outcome than the uterine artery Doppler waveform has an early

diastolic notch in the nonpregnant state. It also persists in the pregnant state until 20-28 weeks of gestation[40].

Presence of a notch is a significantly better predictor of poor pregnancy outcome than the S/D ratio or the resistance index (RI). It has been reported that an increased uterine artery RI without a uterine notch poorly correlates with adverse perinatal outcome[41]. The complexity of the uteroplacental circulation makes accurate identification of the vessel under study difficult with either continuous wave or duplex Doppler ultrasound. Flow velocity waveforms are obtained from the lateral lower quadrants of the uterus, angling the transducer on either side of the uterus towards the cervix. Signals achieved in this way are assumed to be originating from the uterine arteries. The uterine arteries are more accurately identified using color Doppler: the region lateral to the loweruterus is examined and the external iliac artery and the adjacent vein are identified. The uterine artery crosses the external iliac artery on its course from the internal iliac artery to the body of the uterus. It is important to angle the transducer to improve the angle of insonation while maintaining vessel identification on the color Doppler. Spectral waveforms are obtained by placing the pulse Doppler range gate within the vessel at this point.

In the non pregnant state, the uterine artery is a high resistance vessel. It shows a high resistance waveform. Low diastolic flow and early diastolic notching is a normal feature of the non-pregnant uterine circulation. With

pregnancy, trophoblastic invasion of the spiral arteries takes place converting the high resistance flow pattern into that of a low resistance pattern characterized by increase in diastolic flow and disappearance of the notch. It is essential to study both the uterine arteries because of variations in placentation. In cases of a laterally located placenta, the placental side uterine artery is the main supplier, that it has a lower resistance as compared to the opposite uterine artery.

Examination of both the uterine arteries is an indispensible element of Doppler examination to assess placental performance and risk to the fetus[42]. When the placenta is centrally located, there is equal contribution by both the uterine arteries. In case of a unilateral placenta, if the degree of contribution by the opposite uterine artery is deficient, it can facilitate the development of pre eclampsia, IUGR or both. Therefore before studying the uterine artery it is imperative to know the side of the placenta and determine the "placental side uterine artery".

In abnormal pregnancies due to lack of trophoblastic invasion, there is increased resistance in the placental bed. This increased resistance is reflected back in the uterine arteries.

During the course of pregnancy the uterine artery changes from a high resistance pattern with no notches. Disappearance of notch will happen first in the uterine artery which is directly under the placenta. Normally the notch is

seen until 28 weeks of gestation. Persistence of notch after 28 weeks is an indicator of hypertensive complications/ IUGR or both. Persistence of notch indicates unaltered vasospasm. After delivery, the uterine artery doesn't return to its pre pregnant level for 4-6 weeks. Various indices have been used to describe the uterine artery waveform eg: systolic/ diastolic ratio, RI and PI. These indices in due course of pregnancy should show a fall in theirvalues. Failure of trophoblastic invasion results in increased resistance to flow, a low diastolic velocity and consequent increase in indices causing utero-placental insufficiency. Abnormal Doppler values indicative of a failure to modify the uterine circulation in early pregnancy are associated with preterm delivery, development of Pre eclampsia and SGA fetus.

The upper limit of systolic/ diastolic ratio is approximately 2.6. The systolic/ diastolic ratio more than 2.6 after 26 weeks of gestation suggests that full trophoblastic invasion has not occurred and mother and fetus are at risk for adverse outcome. The upper limit of RI value is about 0.56. Increased values of RI indicate that there is increased risk of IUGR. The RI value will be lower from placental side and from distal accurate than proximal uterine arteries[43]. The difference between the systolic/ diastolic ratio of both uterine arteries should not exceed 1 normally. A difference of more than 1 indicates pre eclampsia and IUGR[44].

Pathological Doppler velocimetry of the uterine and uteroplacental circulation is a powerful predictor of preeclampsia and / or IUGR in high risk pregnancies. Doppler examination of uterine and umblical arteries can detect at mid pregnancy, the severe forms of preeclampsia and SGA fetuses.

Intrauterine growth retardation INTRAUTERINE GROWTH RESTRICTION

Definition

Intrauterine growth retardation has been defined in a variety of ways by different authors. IUGR is defined on the basis of a weight below the 10th percentile for the corresponding gestational age. Small for gestational age and IUGR has been used interchangeably, but now IUGR is restricted for the clinical circumstance of a fetus that is under achieving its growth potential78. Growth restricted fetus have 4-8 times mortality when compared to that of non IUGR fetuses. Growth restricted infants have serious short or long term morbidity including meconium aspiration pneumonia and metabolic disorders[45,46].

Causes:

IUGR has many causes including placental insufficiency which may be primary or secondary to maternal disorder such as hypertension, collagen vascular disease, poor nutrition, drug and alcohol abuse , fetal chromosomal anomalies (trisomy 13 and 18) and fetal infections (cytomegalo virus and toxoplasma)[47,48]placental or cord abnormalities which include placental

infraction, chorioangioma, marginal or velamentous cord insertion, circumvallete placenta, or placenta previa. Primary placental insufficiency is the most common cause of IUGR.

IUGR has been categorized as asymmetrical where growth restricted fetal abdomen is disproportionately small in relation with head and limbs and symmetrical where fetuses are proportionately small in size. The former is more common variety, is the pattern expected in the most cases of primary or secondary to placental insufficiency. The latter is seen in cases resulting from an early insult. There is however, considerable overlap between these two groups.

Pathophysiology:

IUGR is primarily the result of disturbances in placental vascular development[49].In early pregnancy miscarriage may result from inhibited angiogenesis and poor placental adherence. Later in gestation, inadequate trophoblastic invasion into maternal spiral and radial arteries leads to the failure of establishment of a low resistance circuit that is a key to further fetal growth. The fetal response to uteroplacental insufficiency (UPI) can be categorized into early and late cardiovascular adaptations that are relevant to sonographic assessment of fetal status. Early adaptation is characterized by changes in blood flow to favor nutrient and oxygen distribution to essential organs, especially the brain. Umblical venous volume is reduced in early stages of UPI, leading to oligohydramnios due to decreased renal perfusion[50].

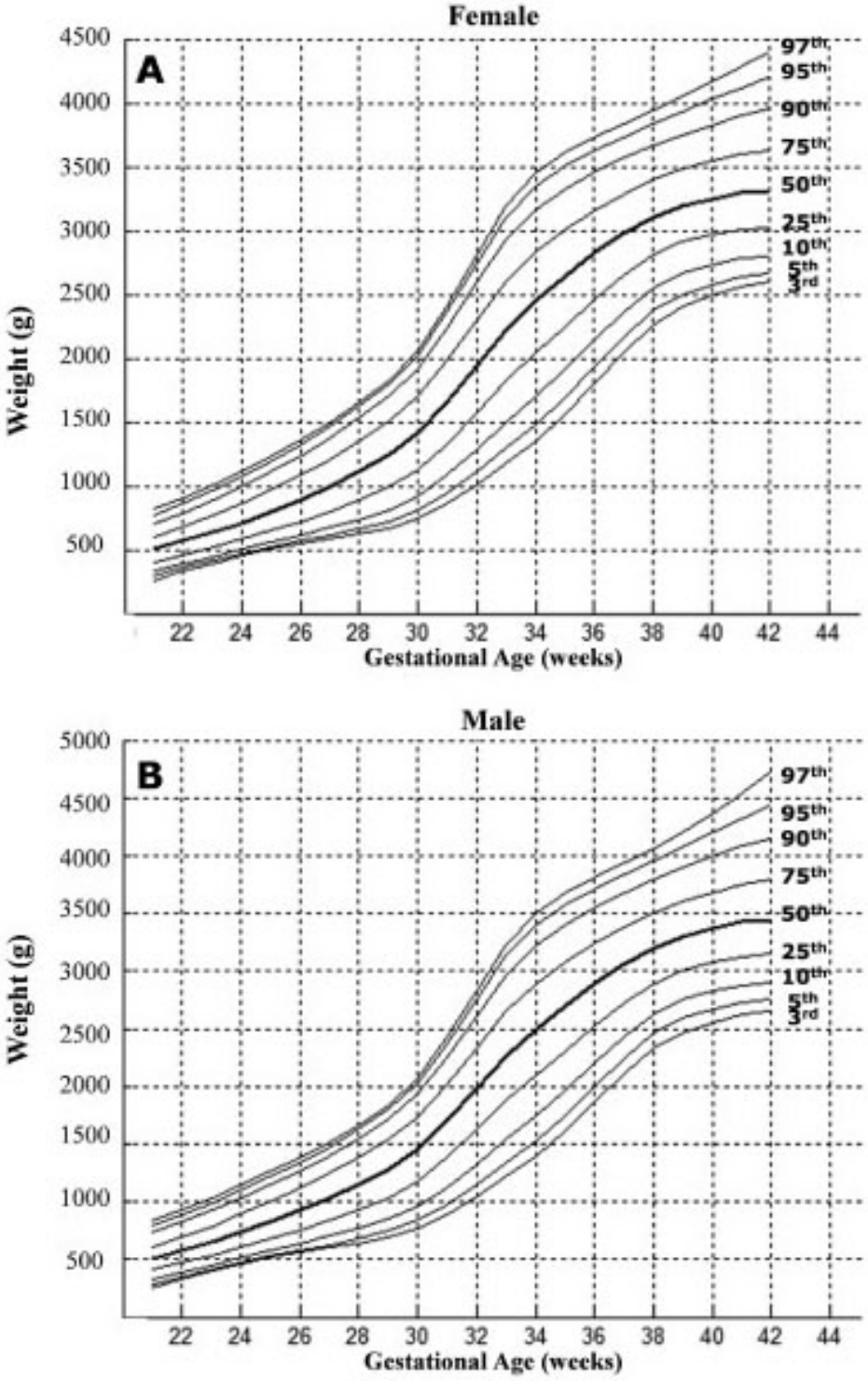


Fig.4. Growth Curves for Male and Female Baby according to Gestational weeks.

This leads to greater diversion of the relatively nutrient oxygen rich umblical venous blood through the ductus venosus away from the liver and to the fetal heart; through the foramen ovale, this blood then enters the left side of the heart, and from there, moves on to the coronary and cerebral circulations[51]. Facilitating this shunting is an elevation in right ventricular after load owing to the high resistance of the pulmonary vasculature as well as the rising placental resistance. A reduction in left ventricular after load occurs as well owing to the drop in cerebral vascular resistance.[52,53,54].

Late changes occur with progressive UPI and increasing placental resistance with development of oligohydramnios. Cardiac output declines owing to the rising after load, resulting in reduced forward flow. As a result, the ability to handle preload is also significantly diminished; leading to elevated central venous pressure and inhibition in forward venous flow[55,56]. The final stage is global myocardial dysfunction and dilatation[57]. Tricuspid insufficiency and spontaneous fetal heart rate deceleration herald impending death[58]

Doppler imaging in monitoring growth retarded fetus :

Doppler imaging is of value for monitoring the pregnancy because it can provide indirect evidence of fetal compromise. Numerous studies support the value of Doppler waveform indexes of the umblical artery and perhaps of fetal cerebral Arteries for assessing the prognosis of fetuses with IUGR. In particular, the frequencies of caesarean section for fetal distress, admission to

neonatal care unit, and perinatal mortality are all two fold to four fold higher in growth retarded fetuses with abnormal umblical artery waveforms and with decreased systolic to diastolic ratio[59-64].

The association between the IUGR and increased perinatal mortality and morbidity has received considerable attention in recent years.[65] The accurate and timely identification of growth-retarded fetus is an important goal that may optimize pregnancy outcome.

There are several methods available to the Obstetricians in the identification of growth retarded fetus. Historically, these methods have involved measurement of uterine size using symphysiofundal height and clinical estimation of fetal weight. These methods may be inaccurate in the presence of maternal obesity, Leiomyomata and polyhydramnios. The advent of real time ultrasound has allowed for sonographic estimation of fetal weight using a variety of computer generated formulas.[66-68] In the setting of accurate pregnancy dating, the sonographic estimation of fetal weight may prove to be of great value in the identification of growth retarded fetus.[69]

Doppler analysis of uteroplacental and fetal circulation is a technique that may be particularly well suited to the identification of growth-retarded fetus.

IUGR is a condition that may result from broad variety of patho physiologic mechanisms of which placental insufficiency is one such condition.

Creasy et al[70] demonstrated that when the placental circulation of fetal lambs was embolised using microspheres, a 30% decrease in birth weight

occurred. Microsphere embolisation is thought to decrease the placental surface available for nutrient and gas exchange, and may be associated with an increase in impedance to blood flow. During the progress of normal pregnancy an increase in placental size and flow has been demonstrated. Deficient placental growth and function may clearly result in the development of **IUGR.** These placental abnormalities may be detected using Doppler velocimetry.

This, in fact, is the theoretical basis on which the use of Doppler velocimetry to diagnose IUGR has been proposed.

Umblical artery velocimetry

Umblical artery velocimetry impedance may be characterized by number of empiric indices including systolic diastolic S/D ratio. The resistance index RI and pulsatality index (PI). Measurement of these indices is associated with an error of 10-20%[71]. Recording of the umblical artery flow velocity waveform is commonly obtained from a free loop of umblical cord. Although some differences in measurement may be noted depending on whether fetal, placental or central areas of the umblical cord are interrogated, these differences are minor and usually does not have significant impact on clinical decision making.[72]

A characteristic umblical flow velocity waveform has a rapid upstroke during systole and gradually declines during diastole, while maintaining continuous forward flow. Since blood flow during diastole is largely passive

and relates in large measure to the number of tertiary stem villi available to absorb the circulating volume, a decrease in peripheral impedance results in increase in end diastolic flow velocity. Conversely increase in peripheral impedance as may be seen in cases of placental insufficiency is likely to result in abnormalities such as decrease, absent or reversed end diastolic flow.

As gestational age advances and placental growth continues, a significant increase in the number of small arterial channels and tertiary stem villi occurs. This results in placental vascular stress that is expanding with advancing gestational age and whose impedance to flow is decreasing since decreasing impendence to flow increases the passive diastolic component of the wave form, we note that end diastolic velocities characteristically increased with advancing gestational age. Thus the indices used to describe the flow velocity wave from such as S/D decrease with advancing gestational age.[73] Indices prior to 20-week gestation are of limited value because of low or absent end diastolic velocity. Although variation has been reported there is decrease in mean value of all indices during latter half of pregnancy.

Abnormal umblical circulation Abnormal flow may represents failure of angiogenesis resulting in increase resistance. Flow abnormalities can be mild to severe with either absent diastolic component or reverse of diastolic flow seen in umblical circulation. Abnormal umblical artery flow pattern with

reduced diastolic flow is associated with presence of maternal hypertension and IUGR.

UMBLICAL ARTERY:

Umblical artery flow velocity waveform correlates the hemodynamic changes in the fetoplacental circulation or in other words reflect downstream (placental) vascular resistance. With the aid of color flow, the umblical arteries can be detected as early as 8-10 weeks. A characteristic umblical artery FVW has a rapid upstroke during systole and a gradual decline during diastole, while maintaining a continuous forward flow. A decrease in peripheral resistance results in an increased end diastolic velocity. Conversely, increased peripheral resistance (as seen in cases of placental in sufficiency) likely results in decreased, absent or even reversed end-diastolic flow.

Uterine artery Doppler in Preeclampsia and IUGR

Camphell et all (1983)[31] was first to report uterine artery Doppler velocimetry. They showed that compared to pregnancies with normal uterine artery waveforms, pregnancies with abnormal uterine artery Doppler waveform were associated with more preeclampsia, required more anti-hypertensive therapy, and resulted in lower birth weights in younger gestation ages at birth. Thus the capability of this potentially safe non-invasive prospective means of analyzing uterine artery blood flow during pregnancy was realized and set-off a wave of interest and research over the ensuing years.

Gerard Albaiges[74] et a (2000) conducted a study on one-stage Preeclampsia for pregnancy complications with Doppler assessment of uterine arteries. Women who had highest risk are those with bilateral notches and high mean pulsatile index. They have 40% chances of developing pre-eclampsia, 45% of developing infant birth weight less than 10% percentile.

Harrington[75] et al (1991) reported on two mid pregnancies Screening studies on 925 patients in predicting subsequent development of PREECLAMPSIA and IUGR. There was a significant association between abnormal flow (RI higher than the 95th percentile) and subsequent gestational hypertension and IUGR. There was no significant association with non proteinuric hypertension. To improve the sensitivity, color flow imaging and use of the diastolic notch as well as elevated RI was introduced. In this study 2437 were patient studied at 20 weeks gestation, 16% had abnormal waveforms. 5.4% persisted at 24th week and 4.6% persisted at 26 weeks of gestation. Therefore the high sensitivity of 76% at 20 weeks was maintained at 24 and 26 weeks while specificity improved from 86% to 97%.

These Preeclampsia studies may play important role in targeting population at risk. Kurdie et al[76] (1988) examined the uterine arteries by Doppler in 946 unselected women at 19-21 weeks. In 12.4 of cases, there were bilateral notches and in this group, the odds ratio for developing pre-eclampsia was 12.8, and for patients requiring delivery before 37 weeks, it was 52.6 when the uterine artery Doppler studies were normal, the odds ratio for developing pre-

eclampsia was 0.11 and for fatal growth restriction (birth weight <5th percentile for gestational age), it was 0.3 in women with bilateral notches and a mean resistance index >0.55, the sensitivity and for the complications requiring delivery before 37 weeks, the sensitivities were 88 for both. It was concluded that women with normal uterine Doppler study at 20 weeks constitute a group that have a low risk of developing obstetric complication related to uteroplacental insufficiency, whereas women with bilateral notches have an increased risk of subsequent development of such complications, in particular those requiring delivery before term. Consequently the results of Doppler studies of uterine arteries at time of routine 20 weeks anomaly scan may be of use in determining the type and level of antenatal care that is offered to these women.

Antsaklis et al[77] (2000) revised the issue of gestational age at Preeclampsia and placental localization in a low risk population of nulliparous women. They reported that using the definition, “any notch” and for pre-eclampsia requiring delivery before 34 weeks, sensitivity over 90. Also Preeclampsia at 20 rather than 24 weeks has higher sensitivity 81 and lower specificity 84. The authors specified that for a fully lateral placenta, the sensitivity of unilateral or bilateral notches for pre-eclampsia reduced significantly from 88 for a mid-position placenta to 33 for a lateralized placenta. Also that in case of lateralized placenta, the flow through the placental side uterine artery is more important a

determinant of uteroplacental flow. They concluded that screening test is best performed at 24 weeks.

Bower et al[78] (1993) They conducted a cross sectional study on 2430 women between 18-22 weeks to obtain velocity waveforms from both uterine arteries. Their outcome measures were intrauterine death, ante partum hemorrhage and three different degrees of severity of pre-eclampsia and growth retardation. They found that by including an early diastolic notch, the prediction of pre-eclampsia improved markedly. They concluded that this simple test can be performed at a routine visit and a group of women can be identified for further assessment and possible therapeutic interventions.

Schulman et al[79] (1989) Preeclampsia on 255 women in general obstetric population found 9 positive results. 7 of these were true positives for hypertensive syndromes, but the most significant disease was seen when there was a co-existing abnormal flow velocity in the umblical artery.

C. J. Bhat et al[80] (2003) studied role of Doppler in gestational hypertension. In this study, out of 100 gestational hypertension cases 56% had abnormal S/D Ratio in umblical artery and / or uterine artery. 60% of these patients delivered IUGR babies. In patients with absent end diastolic velocity and reversed end diastolic velocity perinatal mortality was 50% and 50% had IUGR babies. The results of abnormal umblical artery were more significant than uterine artery in Preeclampsia perinatal outcome.

Zimmerman et al[81] (1997) studied 175 women at high risk and 172 patients at low risk for pregnancy induced and fetal growth restriction in a prospective cross sectional trial. Their parameters were waveforms from uterine arteries, uteroplacental arteries in region of placental implantation and umblical artery at 21-14 weeks. They defined as abnormal, persistent notches in the main stem uterine arteries and elevated resistance indices of > 0.68 in the uterine arteries and > 0.38 in the utero placental arteries. The incidence of (Preeclampsia) and intra uterine growth retardation was recorded as main outcome measure. They found that abnormal outcomes were 58.3 when Doppler was abnormal and 8.3 if Doppler results were normal. They concluded that combination of all parameters was superior to a single parameter and a bilateral notch superior to unilateral. Pathological Doppler velocimetry was a powerful of Preeclampsia and /or fetal growth restriction in high-risk pregnancies.

In a study by Murlidhar V. Pai[82] (2001), total of 111 singleton pregnant women were subject to Doppler, between 18-22 and 24-28 weeks. The RI of the uterine at both the intervals was calculated. RI at both the intervals in women with normal pregnancy was correlated with the outcome variables, namely, development of Preeclampsia and / or IUGR. It was found that RI were significantly higher in women who developed Preeclampsia and had IUGR babies, hence it was concluded that abnormal RI may herald the development of Preeclampsia and/or IUGR and may be used as a screening test.

North et al[13], (1994) used Doppler ultrasound to obtain uterine artery waveforms at 19-24 weeks' gestation in 458 nulliparous. This method identified 51% of women with subsequent Preeclampsia or SGA infants and had a positive predictive value of 29%. The test detected women with severe disease requiring delivery before 37 weeks with a sensitivity of 83% and specificity of 88%. A normal test predicted an uncomplicated pregnancy.

He concluded that, although abnormal uterine artery Doppler is associated with an increased risk of Preeclampsia and FGR,the positive predictive values do not support its introduction as a routine Preeclampsia test in nulliparas women.

Various parameters of the flow waveforms have been studied as predictors of abnormal perinatal outcome.

Bewley et al[83] (1991) studied uteroplacental blood flow and found that pregnancies with high AVRI values had higher prevalence of Preeclampsia, placental abruption, and small for gestational age babies and fetal loss. When AVRI was more than 95th centile, the overall risk of pregnancy complication was 67% and the risk of severe complication was 25%. However the sensitivity was only 13% and 21% respectively. They concluded that Doppler Preeclampsia thus detects abnormal outcomes; the predictive values do not justify its introduction as routine test. Kofinas, et al[84] (1992) evaluated uterine artery resistance in 123 pregnant woman. In patients with unilateral placentas (n =67) the placental uterine artery was found to be a better predictor of poor

pregnancy outcome than the non-placental artery and the mean of the two arteries. Unilateral placental location was associated with longer stays in neonatal intensive care units and more perinatal deaths. The time of examining the uterine flow has been studied extensively.

Harrington et al[85] (1996) reported a reduction in the incidence of notching from 16 at 18-22 weeks to 8.9 at 24 weeks, and suggested an abnormal Doppler should be definitively diagnosed at 22-27 weeks to reduce to false positive rate.

Oliviere Irion et al[86] (1998), carried out a two stage Preeclampsia of the uterine arteries at 18 and 26 weeks og gestation. At 26 weeks all the abnormalities of the studied Doppler indices were significantly associated with pre-eclampsia and low birth weight for gestation. The performance of the Doppler measurements performed at 18 weeks was poor and concluded that uterine artery Doppler velocimetry waveform analysis does not qualify as a reliable screening test for pre-eclampsia or low birth weight for gestation in low risk pregnancies but may be useful in selected high risk populations.

Umblical artery Doppler in Preeclampsia and IUGR

The utility of umblical artery Doppler velocimetry in the Preeclampsia of low risk population for IUGR.

Beattie and dornan[87] (1989) studied 2097 pregnancies of confirmed gestation age were studied at 28, 34, 38 weeks of gestation. The sensitively of Doppler velocimetry in detecting IUGR ranged from 31-40%.

Bruinse et al[88] (1989) performed a similar Preeclampsia study on 405 unselected patients they noted a sensitivity of 17% for an examination performed at 28 weeks gestation and sensitivity of 22% for examination performed at 34 weeks gestation.

Wendy Atkinson et al[89]. (1994) examined a total of 1665 doppler studies on 565 women. Fourty-four foetuses developed FGR and 21 women were diagnosed with Preeclampsia. The positive predictive values of an abnormal S/D for the sub sequent development of FGR were 13-17% across the gestation age ranges studied, and the positive predictive values for Preeclampsia were 0-5% and he concluded that elevated umblical artery S/D is not a clinically useful predictor of either FGR or Preeclampsia in a low-risk population.

Fleischer et al[90] (1985) studied 189 pregnancy which was high risk with umblical artery wave form and showed that as the S/D ratio increased, the birth weight percentile decreases. The sensitivity and specificity of S/D ratio of more than 3 in identifying IUGR fetus was 78% and 85% respectively, based on these data, and S/D ratio of more than 3 was proposed as abnormal beyond 30 weeks gestation.

Trudinger et al[91] (1991) updated its experience and reported 2178 high risk pregnancies in which Doppler studies of umblical arteries were performed

(22). The incidence of IUGR in this populations (defined as birth weight <10th percentile) was 27% Half of all growth retarded fetus studied had S/D ratio > 95% percentile for gestational age. In this group of patients the odds ratio (O/R) of the fetus with an elevated S/D ratio having IUGR was 5.9 (95% confidence interval 4.7-7.3). They also observed that preterm infants with abnormal S/D ratio spent twice as long as in the NICU as preterm infants with normal S/D ratio.

TABLE 2: Normal Values of S/D ratio in umblical artery Doppler

SI. No.	GA in Weeks	5th Percentile	50th Percentile	95th Percentile
1	26 wks	2.5	3.3	5
2	27wks	2.44	3.23	4.76
3	28wks	2.38	3.13	4.55
4	29 wks	2.33	3.03	4.35
5	30 wks	2.27	2.94	4.17

TABLE 3: Normal Values of RI in umblical artery Doppler

S.No	RI	50th Percentile	95th Percentile
1	26	0.68	0.80
2	27	0.67	0.79
3	28	0.66	0.78
4	29	0.65	0.77
5	30	0.64	0.76

Uterine and umblical artery Doppler in Preeclampsia and IUGR.

Severe hypertension in pregnancy in associated with elevated umblical Doppler velocimetry indices. These observation demonstrate the relationship between the placentile vascular lesions and maternal disease. In most cases abnormal umblical artery waveforms precedes the clinical manifestation of

material diseases. But investigators have realized that a comprehensive analysis of pregnancy associated hypertension requires evaluation of uterine and the umblical circulations.

Ducey et al[92] (1987) al studied 136 pregnant-women with hypertension with Doppler velocimetry of the uterine and umblical arteries. Foetuses of women with abnormal uterine or umblical systolic/diastolic ratios weighted less and were delivered earlier than those whose mothers had normal values. Twenty-nine percent ($p<0.01$) of foetuses in the group with normal uterine and abnormal umblical artery ratios were small for gestational age. Seventeen percent of foetuses in the group with normal umblical and abnormal uterine artery ratios were small for gestational age and 51% ($p<0.001$) of foetuses in those in whom both ratios were abnormal were small for gestational age. Overall 27 small for gestational age infants were delivered during this study. Doppler velocimetry of either the umblical or uterine arteries was abnormal in 26 of them (96%). Results show that Doppler-derived vascular patterns correlate well with normal and adverse perinatal outcome. A description of the uterine and umblical systolic/diastolic ratios should be part of the clinical evaluation of all pregnant women with hypertension. This should lead to better treatment protocols and improved clinical outcome.

Trudinger et al[93] (1985) studied 172 pregnancies which were high risk for fetus of which 53 resulted in delievery of small for gestational age.neonatal

morbity was observed in abnormal umblical studies with low diastolic flow velocities indicating high resistance.in the study 13 cases have an abnormal uterine study and 21 cases normal.In cases of severe maternal hypertension both the uterine artery and umblical artery were abnormal.

Harold Schulman et al[94] (1989) did doppler uterine and umblical arteries starting at the twentieth week of gestation. When a cut off value of 3 was used at 30 weeks for the umblical arteries, there were 35 (13%) positive tests. In 20 of these, values fell to < 3 in ensuring weeks and were considered false positive. The remaining 15 babies demonstrated positive clinical pathologic correlates. When a value of 2.6 was used at 26 weeks for uterine arteries, there were nine positive results seven of which had clinical pathologic correlates. This study suggested an overall positivity rate of 7% therefore it provides encouragement for a larger an overall positivity rate of 7% therefore it provides encouragement for a larger venture in which Preeclampsia and impacts on decision-making are evaluated.

Hanretty et al[95] (1989) did Doppler of umblical arteries in 543 unselected women attending an antenatal clinic. Overall, 357 women studied at 26-30 weeks and 395 at 34-36 weeks; 209 were studied at both gestation periods .normal and abnormal wave forms had no difference in pregnancy outcome, but birth weights were significantly lower in those with an abnormal umblical artery waveform at either gestation. There were no other statistically significant differences between groups.

METHDOLOGY

Methodology

This is a prospective study done over a period 1 yr at Coimbatore medical college from june 2012 to 2013. 105 women with singleton pregnancy attending Coimbatore medical college OPD were subjected to uterine and umblical artery Doppler along with morphology and biometry scan. After fulfilling the inclusion and exclusion criteria. The study is prospective cohort study.

Inclusion criteria

1. All the antenatal womens (in second trimester) of age between 20-30yrs
2. Primigravida and Multigravida with no Previous History of Preeclampsia .

Exclusion criteria

- Patient with congenital anomaly of fetus, multiple gestation, chronic hypertension, renal disease, cardiac disease.
- Exclude patient those who are not getting booked for delivery at Coimbatore medical college.
- Exclude patients with unreliable LMP details and not confirmed by first trimester scan.

When above criteria are met study group was subjected to Doppler study after biometry and morphology scan.

Procedure

Data collected by (Sonoscape 5000 SSI) machine with convex probe 5MHZ-5MHZ with ultrasonography fetal biometry and morphology scan was

done then Doppler mode was switched on. Patient is put in recumbent position with transducer in the longitudinal plane. The external iliac artery is visualized at pelvic side wall with color Doppler. The transducer is then angled medially towards the uterine arty. The spectral waveforms on the right and left uterine arteries were taken, when 3 or 4 waves of equal height were seen, the image was frozen and measurements were taken either by trace method/manually/automatic trace. Then Doppler indices were obtained directly from the machine.

Then transducer is placed over anterior abdominal wall over the uterus and is carefully manipulated till a free loop of umblical cord seen by gray scale imaging and colour was used to identify the umblical artery. Thus Doppler waveform was obtained. Recordings of umblical artery are obtained from free loop of umblical cord. These were identified with the characteristic audio output and typical Doppler shift waveforms appearance on the screen. It was done in fetal apnea as breathing alters the Doppler shifts. Waveforms obtained were maximum frequency shift along with venous flow signals display in reverse side. When 3 or 4 waves of equal height were seen the image was frozen and measurement were taken and cursor was moved tangential over the trough and peak. Indices are obtained directly from machine.

The uterine artery and umblical artery Doppler was done. In uterine artery RI, S/D ratio and early diastolic notching was noted and in umblical artery the

RI, S/D ratio, Absent end diastolic flow and reverse end diastolic flow was noted.

The flow velocity waveforms were considered abnormal if there was an early diastolic notch in uterine artery in either right or left uterine arteries S/D, RI exceeds 95th centile of the reference range for that population. In umblical artery if **S/D, RI** exceeds 95th centile and if there is absent and reverse end diastolic flow in velocity in umblical artery.

These patients were followed up till delivery and details of pregnancy events, labour and delivery and neonatal outcome were noted. The abnormal pregnancy outcomes considered are PREECLAMPSIA and IUGR. Perinatal outcomes are considered are IUD, Apgar 5min ,NICU admission low birth weight.

The abnormal outcomes were defined as:

1. PREECLAMPSIA
2. Gestational Hypertension
3. IUGR

a) Pre-eclampsia defined as:

Hypertension i.e ≥ 140/90mm Hg of blood pressure recorded at least on two occasions, 4 hrs apart or a reading of diastolic pressure ≥ 110 mmHg.

Proteinuria of ≥1+ albumin as recorded by dipstick method.

b) Gestational Hypertension

Hypertension i.e ≥ 140/90mm Hg of blood pressure recorded at least on two occasions, 4 hrs apart or a reading of diastolic pressure ≥ 110 mmHg. Without proteinuria

c) IUGR defined as < 10^{th} percentile birth rate for that gestational age.

FIG 5 : RADIOLOGIST PERFORMING DOPPLER STUDY.

FIG 6: DOPPLER SHOWING NORMAL UTERINE ARTERY WAVE FORM

Fig 7 Uterine Artery Waveform with Increased S/D ratio – 4.05 and Increased RI – 0.75

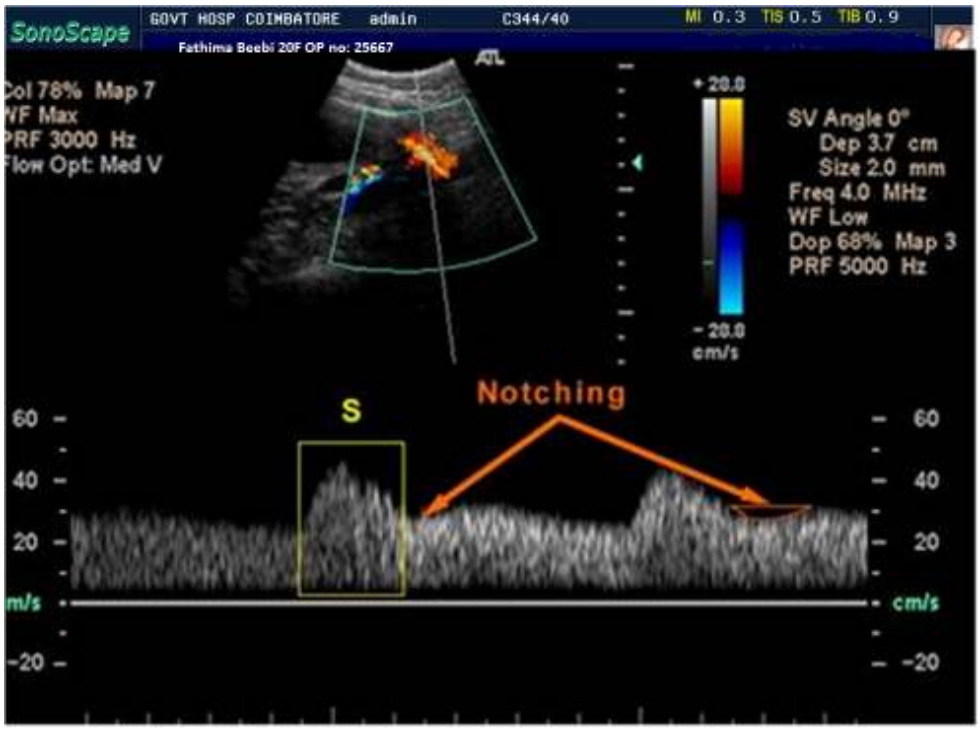


Fig: 8 Uterine Artery Waveform with Early Diastolic Notch.

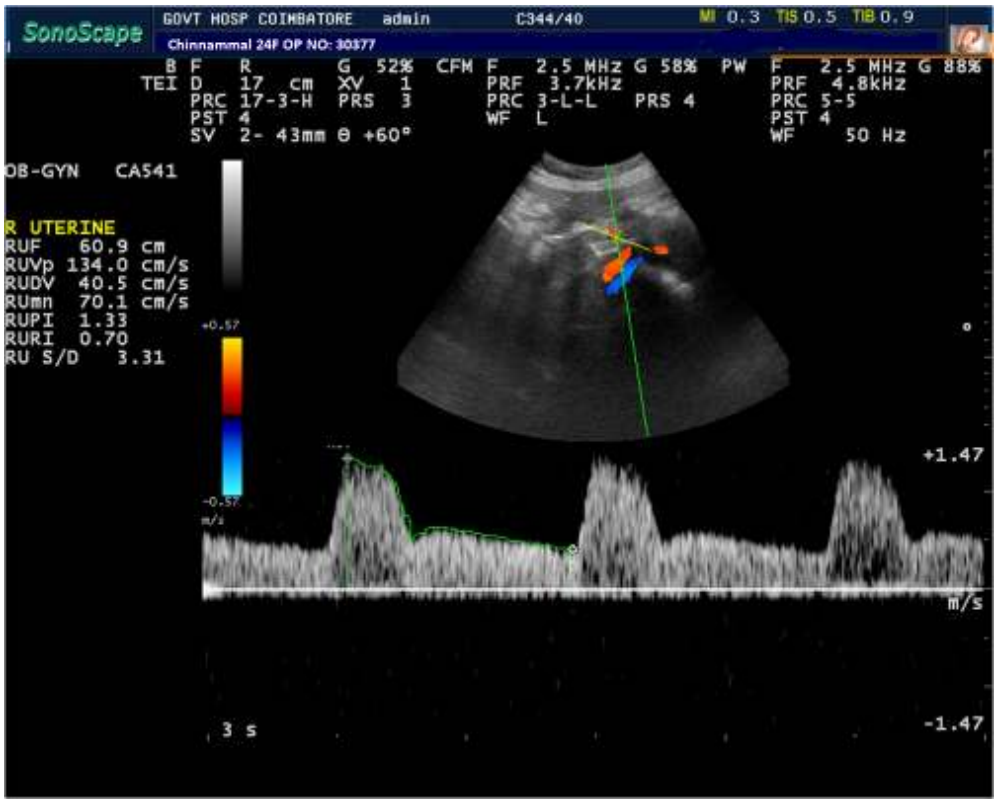


FIG 9: Uterine Artery with Severe Diastolic Notching.

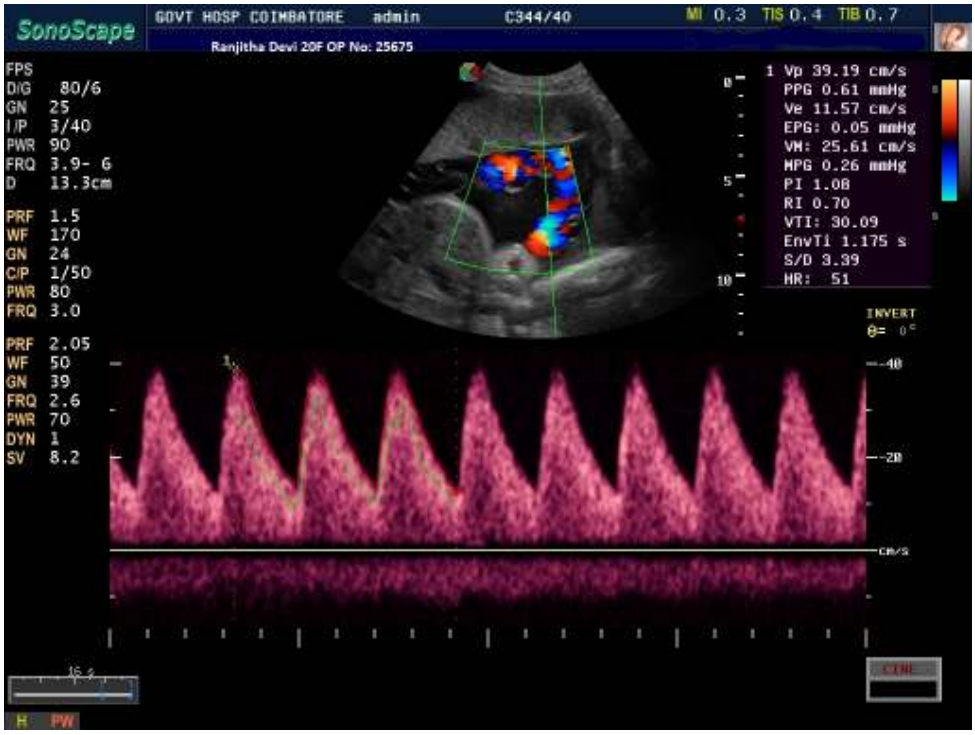


Fig 10: Normal Umblical Artery Waveform

FIG: 11 : Umblical Artery Waveform with Increased S/D ratio – 6.33 Increased RI – 0.84

Fig 12 : Umblical Artery with REDF

Fig 13: Umblical Artery with AEDF

RESULTS AND OBSERVATIONS

RESULTS AND OBSERVATIONS

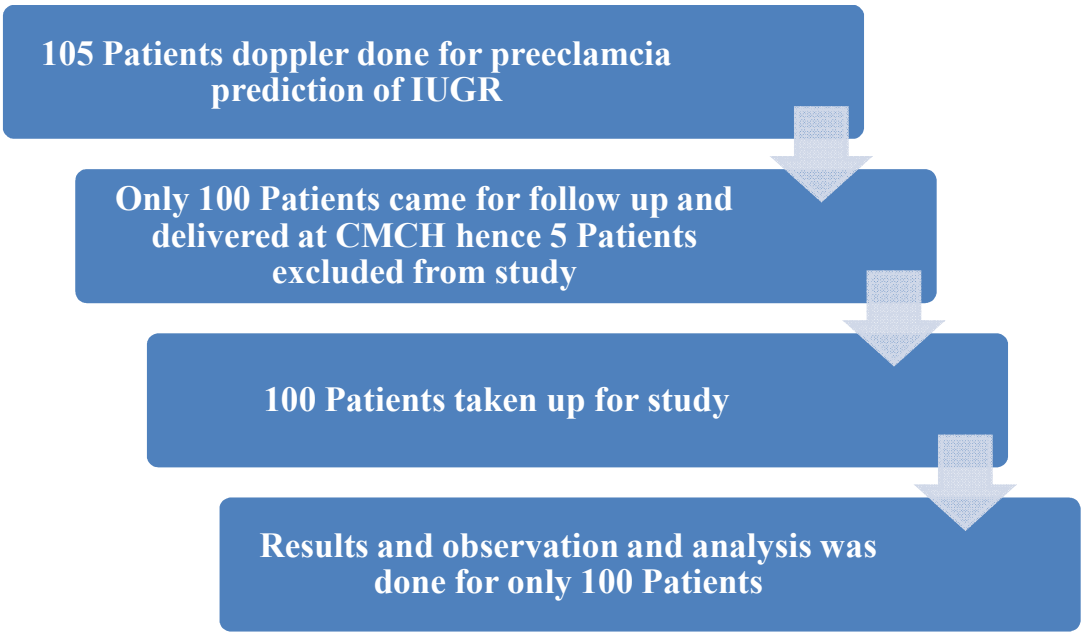


Table 4 - INCIDENCE OF HYPERTENSION

Total Study Population	100
No . Of Cases of Hypertension	15
Incidence of Hypertension	15

According to our study incidence of hypertensive disorders of pregnancy during the study period of one year at Coimbatore Medical College Hospital is 15%

Chart 1- INCIDENCE OF HYPERTENSION

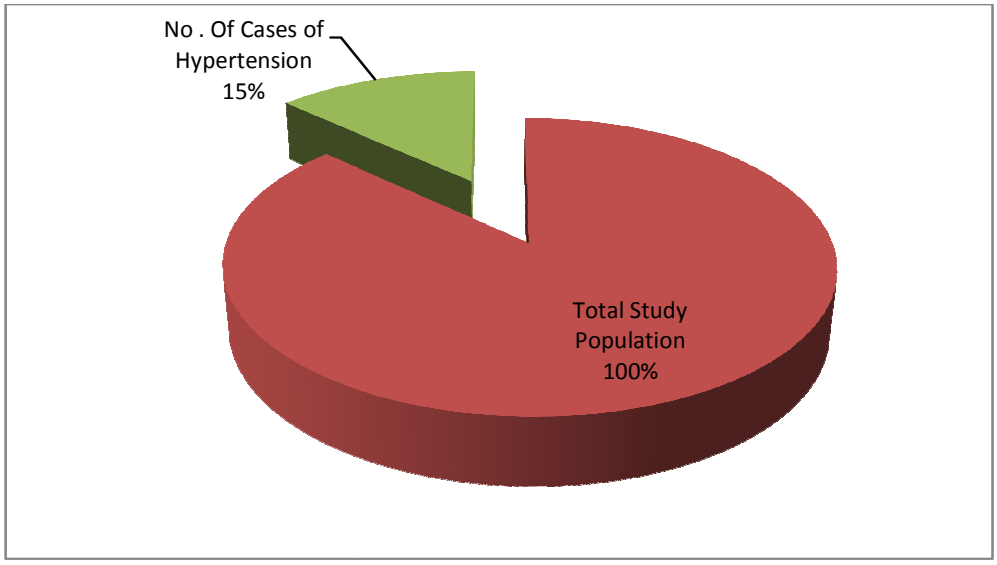


Table 5 : PREVALANCE OF PRE ECLAMPSIA, GESTATIONAL, HYPERTENSION AND IUGR

Conditions	No. of Subjects	Percent
Normal Subjects	74	74
Pre-eclampsia	7	7
Gestational Hypertension	8	8
IUGR	11	11
Total	**100**	**100**

Prevalance of Pre eclampsia, Gestational Hypertension, IUGR – 7%, 8% and 11%.

Chart 2 : PREVALANCE OF PRE ECLAMPSIA, GESTATIONAL, HYPERTENSION AND IUGR

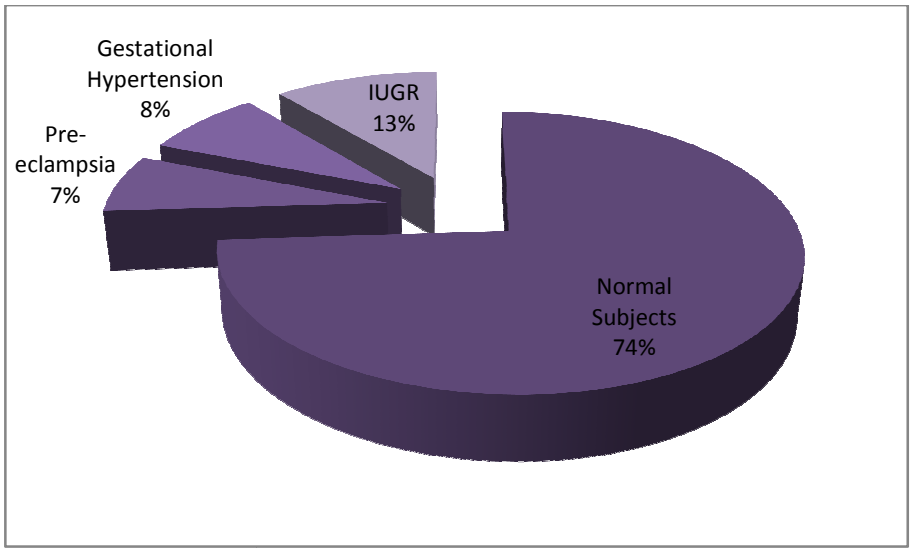


Table 6 : INCIDENCE OF IUGR

Total Study Population	**100**
No . Of Cases of IUGR	13
Incidence of IUGR	13

In the study incidence of IUGR 13%.

Pre Term IUGR - 5

Term IUGR - 7

Chart 3 : INCIDENCE OF IUGR

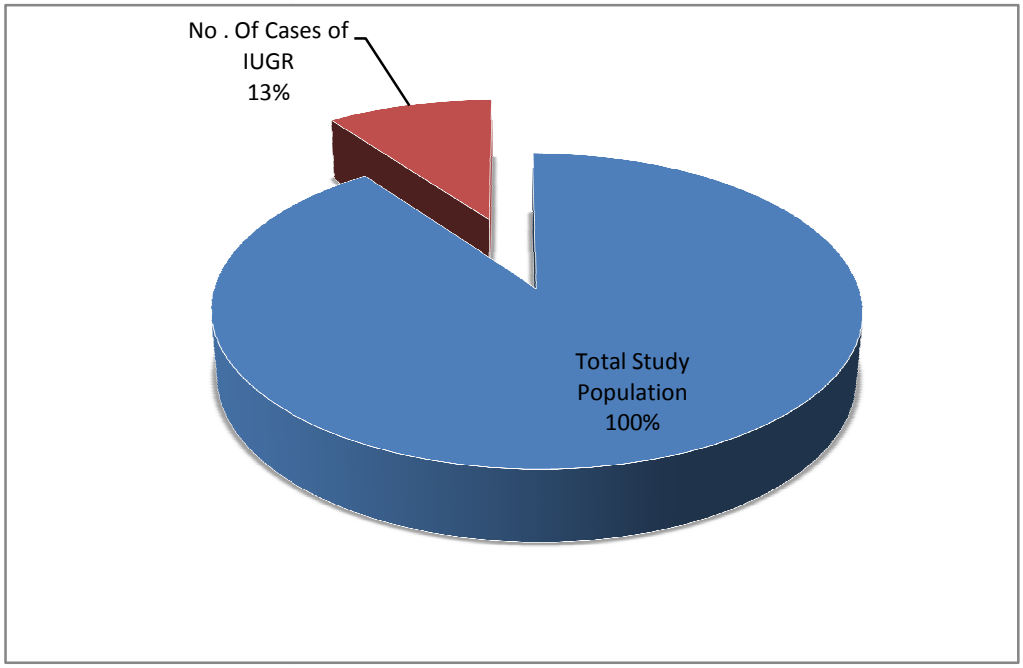


Table 7 : AGE DISTRIBUTION

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
21 - 25 YEARS	76	76.0	76.0	76.0
26 -30 YEARS	24	24.0	24.0	100.0
Total	**100**	**100.0**	**100.0**	

76% are in age group 21 to 25 years.

24% are in age group 26 to 30 years.

Chart 4 : AGE DISTRIBUTION

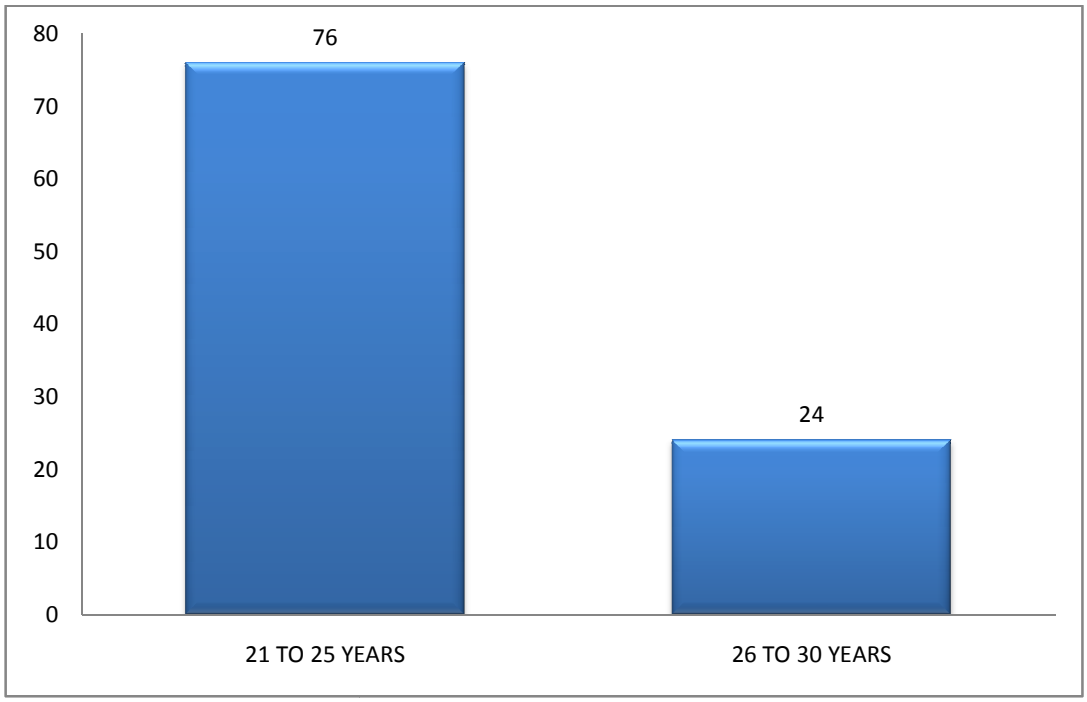


Table 8 : PARITY DISTRIBUTION

Parity	Frequency	Percent	Valid Percent	Cumulative Percent
G2P1L1	9	9.0	9.0	9.0
G3P2L1	2	2.0	2.0	11.0
Primi	89	89.0	89.0	100.0
Total	100	100.0	100.0	

Among 100 study population 89 were primigravida, the incidence being 89% and G2PL1 were (9%), 2(2%) being G3P2L1.

Most of the study population were primigravida

Chart 5 : PARITY DISTRIBUTION

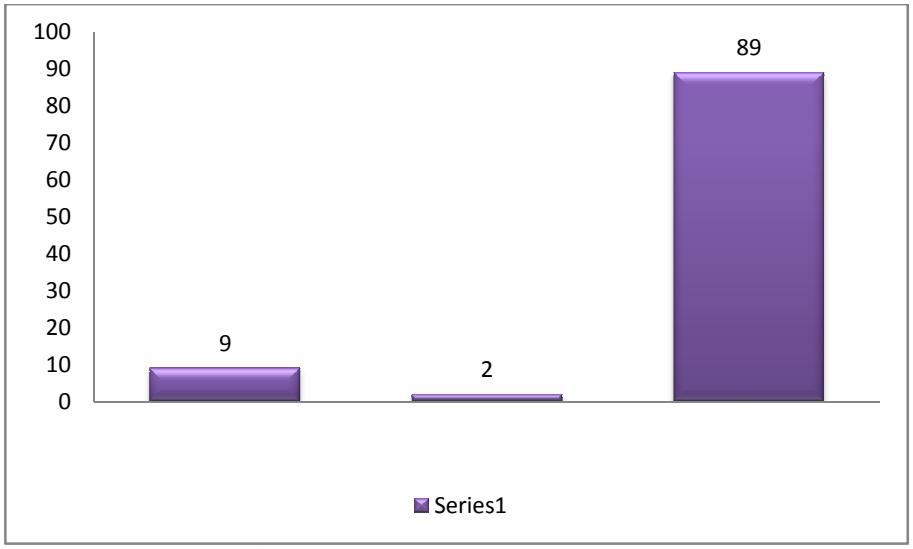


Table 9 : SOCIO ECONOMIC STATUS DISTRIBUTION

SES	Frequency	Percent
Class I,II,III	Nil	Nil
IV	19	19.0
V	81	81.0
Total	100	100.0

The incidence of class IV socio economic status – 19%, Class V – 81%

Chart 6: SOCIO ECONOMIC STATUS DISTRIBUTION

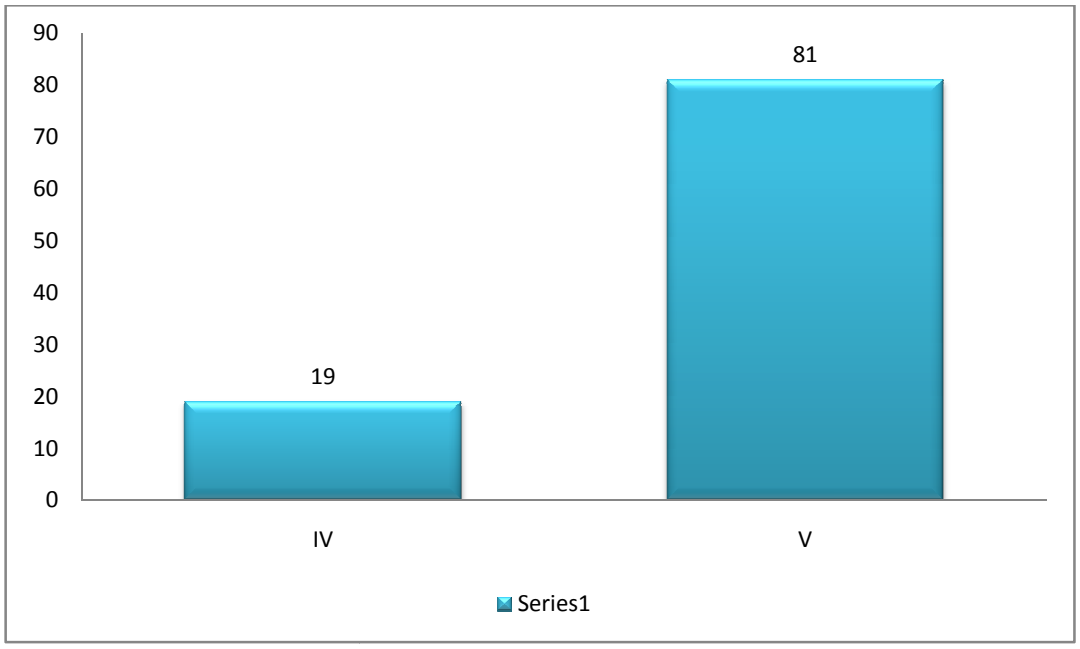


Table 10 : PLACENTAL POSITION

PLACENTA	FREQUENCY	PERCENTAGE
LEFT	21	21
RIGHT	20	20
CENTRE	59	59

The incidence of centrally located placenta is 59%.

The incidence of unilateral placenta (Right and Left) 41%.

Chart 7 : PLACENTAL POSITION

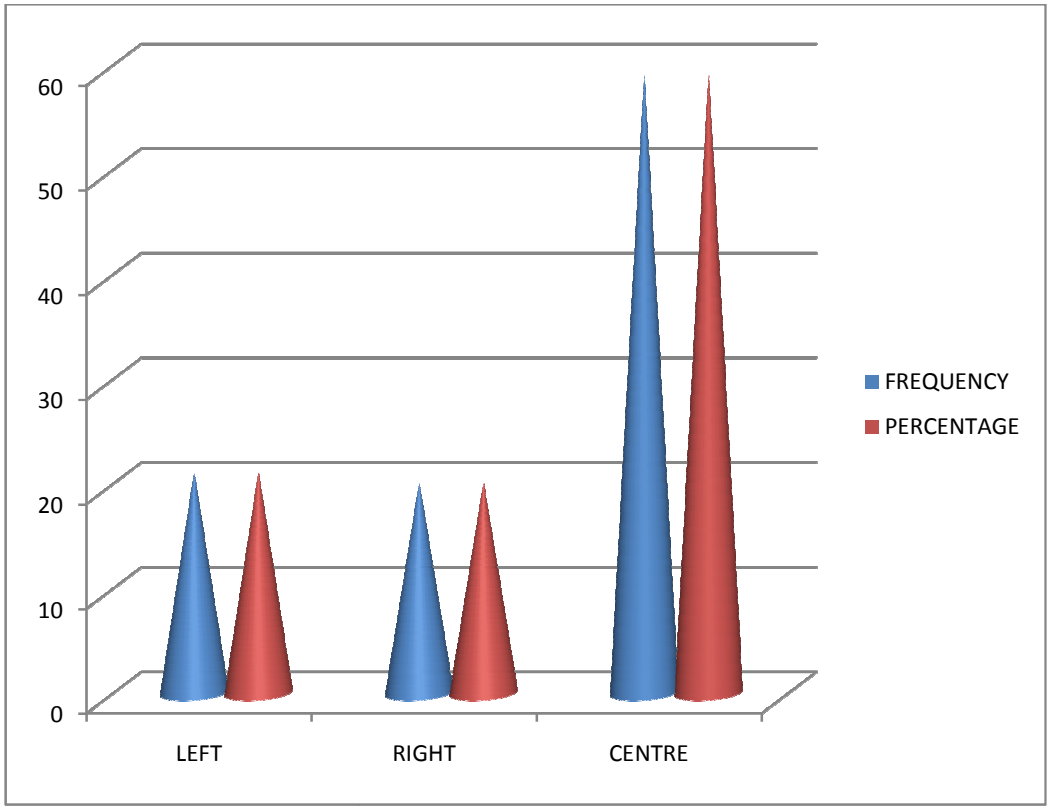


Table 11 : DESCRIPTIVE STATISTICS FOR AGE AND GESTATIONAL AGE AT THE TIME OF SCAN

Study Variable	Mean	No. Of Patients	Std. Deviation	Minimum	Maximum	Std. Error of Mean
Age	24.19	100	1.900	20	30	.190
GA	26.84	100	.721	26	28	.072

Mean Gestational age at the time of scan 26.84 weeks.

Chart 8 : DESCRIPTIVE STATISTICS FOR AGE AND GESTATIONAL AGE AT THE TIME OF SCAN

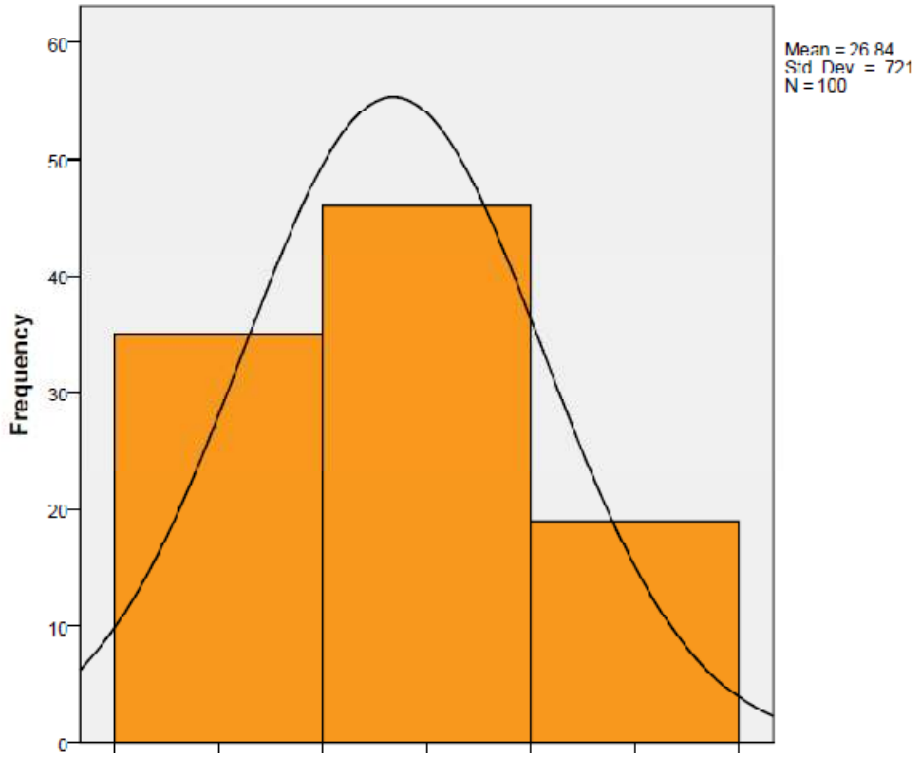


Table 12 : DESCRIPTIVE STATISTICS FOR 95TH PERCENTILE USED FOR THE UTERINE ARTERY DOPPLER INDICES

Study Variable	No. of Patients	Mean	Std. Error	Std. Deviation	Min.	Max.	Percentiles
							95
UTRTSD	100	2.1147	.09884	.98839	1.22	6.20	4.8200
UTLTSD	100	2.0092	.09715	.97154	1.08	8.39	3.8255
UTRTRI	100	.46123	.014907	.149070	.170	.800	.78950
UTLTRI	100	.46438	.016612	.166118	.100	.990	.84600

95% percentile of S/D ratio right uterine artery – 4.8200

95% percentile of S/D ratio left uterine artery – 3.8255

95% percentile of RI ratio right uterine artery – 0.78950

95% percentile of RI ratio Left uterine artery – 0.84600

Table 13 : DESCRIPTIVE STATISTICS FOR 95th PERCENTILE USED FOR THE UMBLICAL ARTERY DOPPLER INDICES

Study Variable	No. of patients	Mean	Std. Error of Mean	Std. Deviation	Min.	Max.	Percentiles
							95
UMSD	100	3.2877	.12882	1.28822	1.07	7.60	6.2785
UMRI	100	.66846	.009303	.093033	.500	.840	.79900

95% percentile of S/D ratio of Umblical artery – 6.2785

95% percentile of RI ratio Umblical artery – 0.79900

Table 14 : TYPE OF DELIVERY

TYPE OF DELIVERY	NO. OF SUBJECTS	PERCENT
Vaginal Delivery	62	62.0
Emergency LSCS	24	24.0
Elective LSCS	14	14.0

Among 29 Patients of abnormal Doppler 25 Patients were induced

12 Patients had vaginal Delivery

13 Patients went for emergency LSCS

4 Patients Went for Elective LSCS

In 100 Patients type of Deliver Distribution

62% of patients had Vaginal Delivery

24% of patients had Emergency LSCS.

14% of patients had Elective LSCS.

Chart 9: TYPE OF DELIVERY

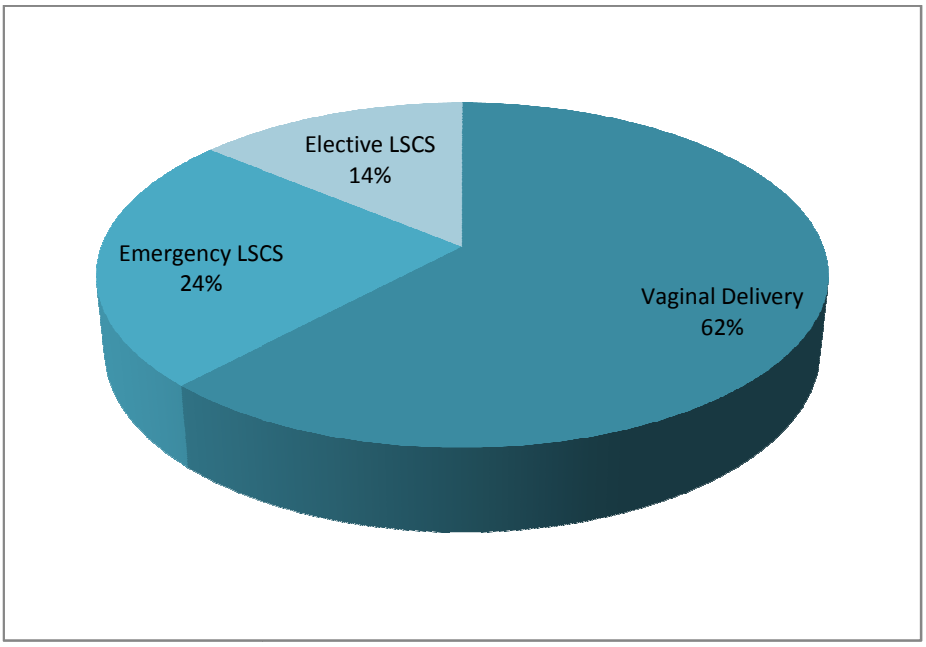


Table 15 : DISTRIBUTION OF THE BIO SOCIAL PHYSIOLOGICAL VARIABLES OF THE STUDY POPULATION

Variable		Frequency	Percent
Parity	Primi gravida	89	89.0
	Multi gravida	11	11.0
	Total	100	100.0
SES	IV	19	19.0
	V	81	81.0
	Total	100	100.0
Albuminuria	Absent	93	93.0
	Present	7	7.0
	Total	100	100.0
Preeclampsia	No	93	93.0
	Yes	7	7.0
	Total	100	100.0
IUGR	No	87	87.0
	Yes	13	13.0
	Total	100	100.0

Primi : 89%

SES V : 81%

Albuminuria : 7%

Preeclampsia : 7%

IUGR : 13%

Chart 10 : DISTRIBUTION OF THE BIO SOCIAL PHYSIOLOGICAL VARIABLES OF THE STUDY POPULATION

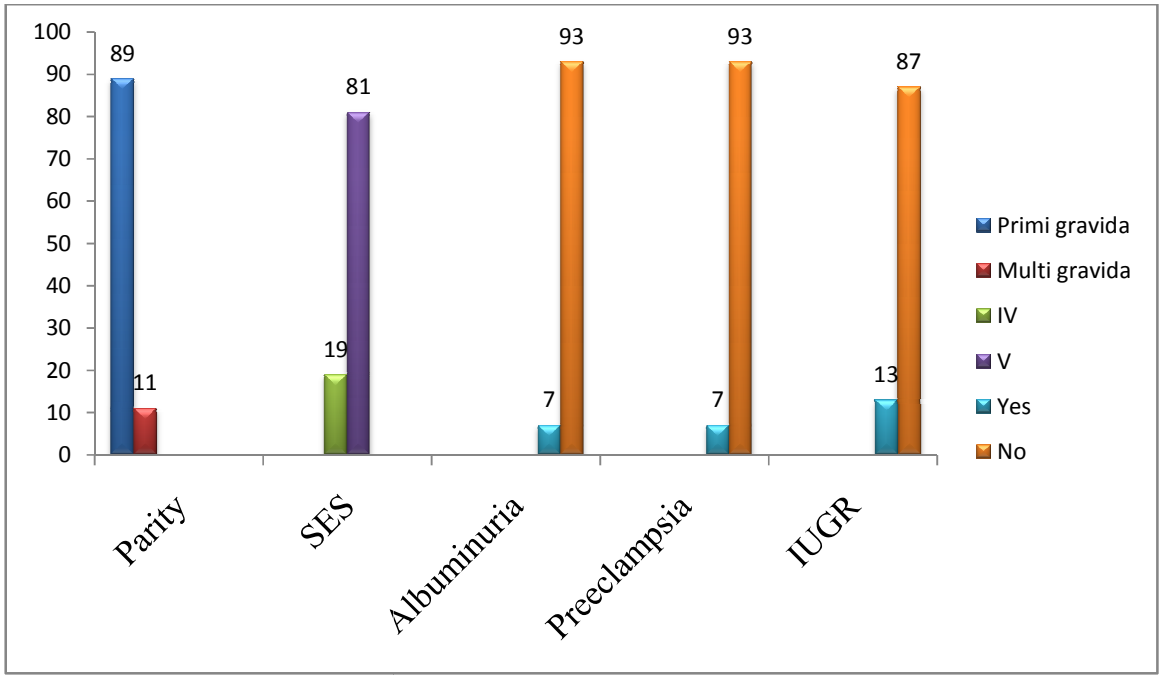


Table 16 : DISTRIBUTION OF THE GESTATIONAL AGE AT THE TIME OF DELIVERY / BWT / APG / STAY IN NICU

Study Variable	No. of Subjects	Min.	Max.	Mean	Std. Error	Std. Deviation
GA at the time of delivery	100	36	40	38.62	.099	.993
BWT	100	1.45	4.20	2.8110	.05628	.56276
APG	100	0	9	8.70	.132	1.322
STAY IN NICU	18	1	22	5.39	1.513	6.418

Mean Gestational age at the time of delivery : 38.62

Minimum birth weight : 1.45 Kg

Maximum birth weight : 4.20 Kg.

Minimum stay in NICU : 1

Maximum stay in NICU : 22

Preterm 18 Term Baby 82

IUGR 13 Pre Term IUGR 5 Term IUGR 7

Weeks		Number of Patients Delivered
36 Weeks		7 Patients in 36 weeks
37 weeks	-	11 Patients
38 weeks	-	25 Patients
39 Weeks	-	43 Patients
40 Weeks	-	14 Patients

Mean Gestational age at the time of delivery : 38.62 Weeks

Chart 11 : DISTRIBUTION OF THE GESTATIONAL AGE AT THE TIME OF DELIVERY / BWT / APG / STAY IN NICU

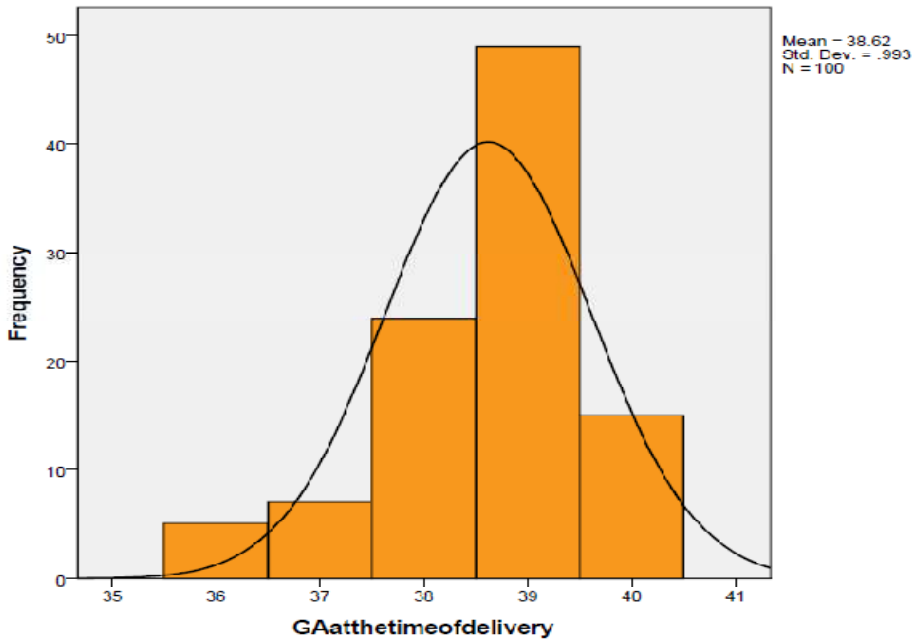


Table 17 : DISTRIBUTION OF THE NEONATAL VARIABLES OF THE STUDY POPULATION

Variable		Frequency	Percent
Stay in NICU	No	82	82.0
	yes	18	18.0
	Total	100	100.0
Birth Weight	LBW	22	22.0
	Normal	78	78.0
	Total	100	100.0

Stay in NICU : 18 %

Low Birth Weight : 22%

Pre Term Baby : 18%

IUGR : 13%

Chart 12 : DISTRIBUTION OF THE NEONATAL VARIABLES OF THE STUDY POPULATION

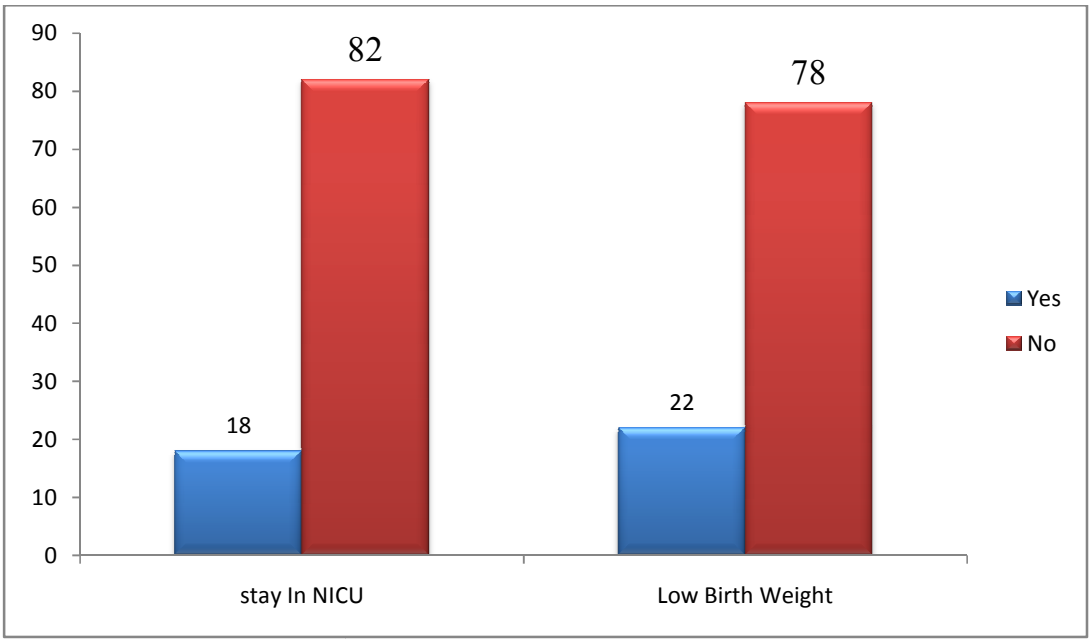


Table 18 : UTERINE AND UMBLICAL ARTERY DOPPLER FINDINGS OF THE STUDY POPULATION

Doppler Findings			Frequency	Percent
Uterine Artery SD	Right	Normal	85	85.0
		Abnormal	15	15.0
		Total	100	100.0
	Left	Normal	87	87.0
		Abnormal	13	13.0
		Total	100	100.0
Uterine Artery RI	Right	Normal	84	84.0
		Abnormal	16	16.0
		Total	100	100.0
	Left	Normal	81	81.0
		Abnormal	19	19.0
		Total	100	100.0
Umblical Artery SD		Normal	90	90.0
		Abnormal	10	10.0
		Total	100	100.0
Umblical Artery RI		Normal	95	95.0
		Abnormal	5	5.0
		Total	100	100.0
Uterine Artery ED notch		No	92	92.0
		Yes	8	8.0
		Total	100	100.0

Uterine Artery doppler S/D Ratio : abnormal (Right 15%, Left 13%)

Uterine doppler Artery RI Ratio : abnormal (Right 16%, Left 17%)

Uterine doppler ED Notch : 8%

Umblical doppler Artery S/D Ratio : Abnormal 10%

Umblical doppler Artery RI Ratio : Abnormal 5%

Chart 13: UTERINE AND UMBLICAL ARTERY DOPPLER FINDINGS OF THE STUDY POPULATION

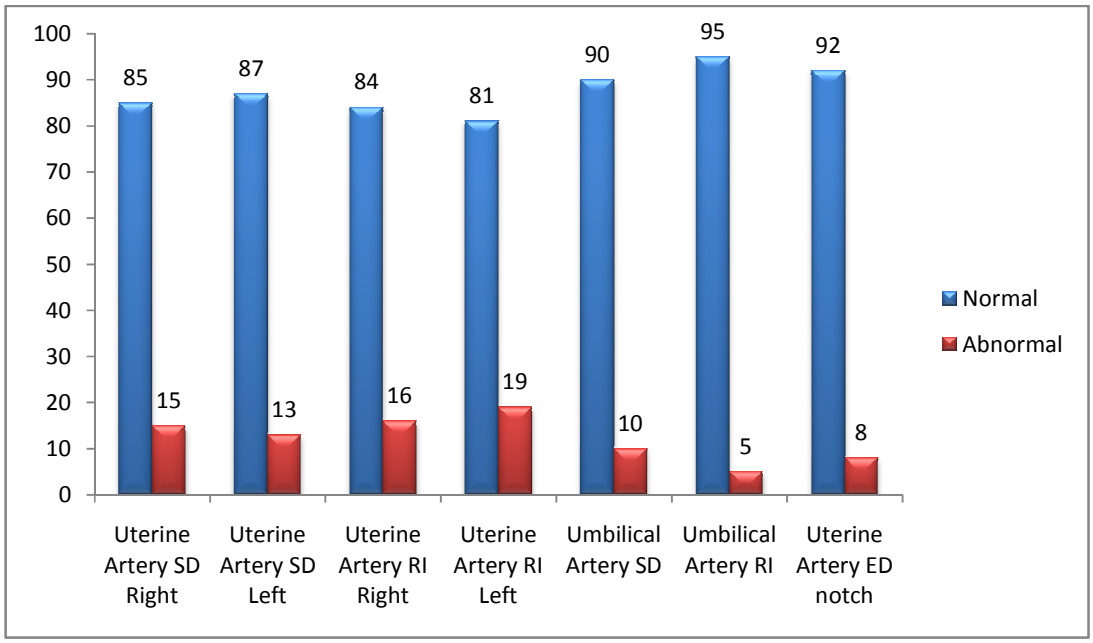


Table 19 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR PREECLAMPSIA

Parameter	Sensitivity	Specificity
Uterine Artery SD Right	85.71	90.32
Uterine Artery SD Left	57.14	90.32
Uterine Artery RI Right	85.71	89.25
Uterine Artery RI Left	57.14	83.87
Umblical Artery SD	42.86	92.47
Umblical Artery RI	28.57	96.77
Uterine artery ED Notch	42.86	94.62

Uterine Artery SD Ratio and ED Notch have more sensitivity hence, more specific predictor for Preeclampsia.

Umblical artery SD has more sensitivity than RI. Hence SD is more specific for Preeclampsia.

Chart 14 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR PREECLAMPSIA

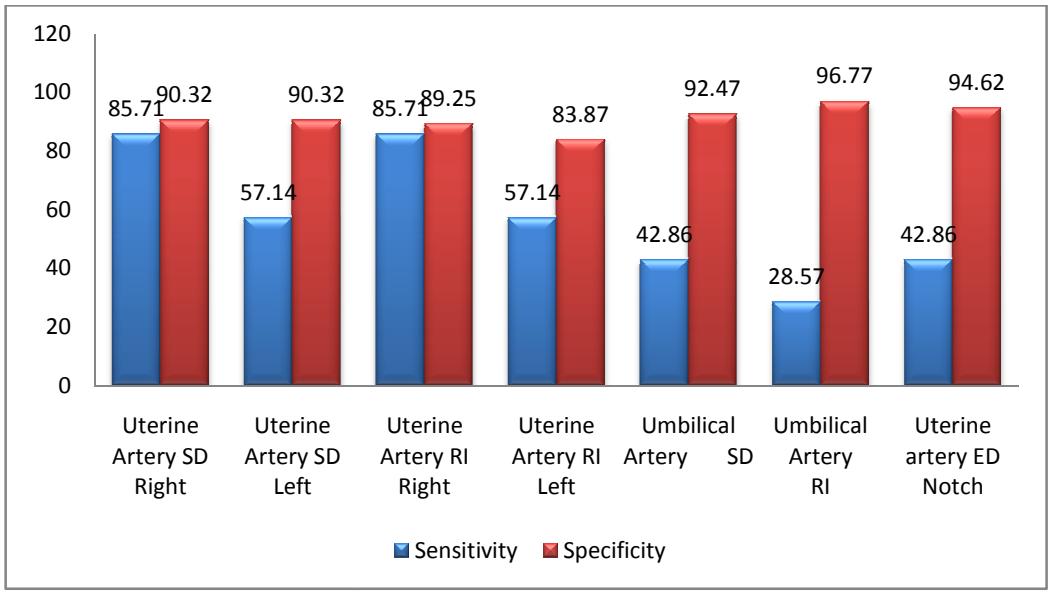


Table 20 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR IUGR

Parameters	Sensitivity	Specificity
Uterine Artery SD Right	53.85	90.8
Uterine Artery SD Left	38.46	90.8
Uterine Artery RI Right	53.85	89.66
Uterine Artery RI Left	38.46	83.91
Umblical Artery SD	69.23	98.85
Umblical Artery RI	7.69	95.4
Uterine artery ED Notch	30.77	95.4

Uterine Artery SD Ratio and ED Notch have more sensitivity hence, more specific predictor for IUGR.

Umblical artery SD has more sensitivity than RI. Hence SD is more specific for IUGR.

Chart 15 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR IUGR

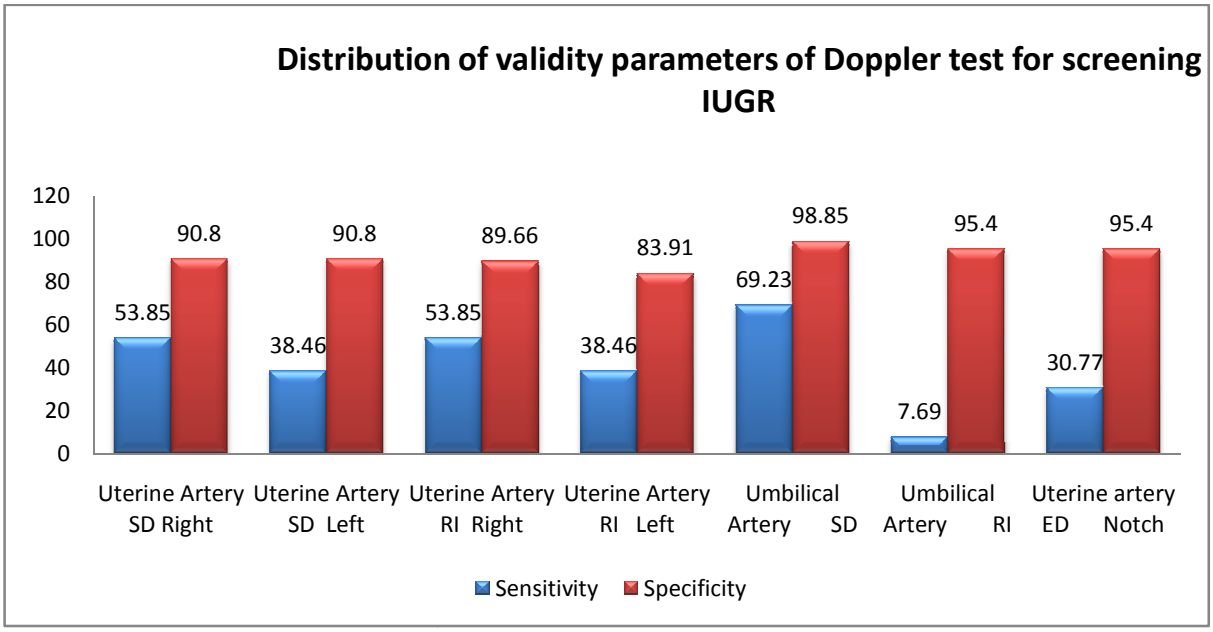


Table 21 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR PREECLAMPSIA (POSITIVE PREDICTIVE VALUE)

Parameter	Uterine Artery				Umblical Artery		Uterine Artery ED notch
	SD		RI		SD	RI	
	Right	Left	Right	Left			
Sensitivity	85.71	57.14	85.71	57.14	42.86	28.57	42.86
Specificity	90.32	90.32	89.25	83.87	92.47	96.77	94.62
Positive Predictive value	40.00	30.77	37.50	21.05	30.00	40.00	37.50
Negative Predictive value	98.82	96.55	98.81	96.30	95.56	94.74	95.65
Percentage of False positives	14.29	42.86	14.29	42.86	57.14	71.43	57.14
Percentage of False negatives	9.68	9.68	10.75	16.13	7.53	3.23	5.38

Uterine artery Doppler indices

Sensitivity of S/D Ratio : Right 85.71%, Left 57.14%

Sensitivity of Notch : 42.86%

Positive Predictive value of S/D Ratio : Right 40.00%, Left 30.77%

Positive Predictive Value of Notch : 37.50%

S/D Ratio is more sensitivity

Umblical Artery Doppler indices

Sensitivity of S/D Ratio : 42.86%

Positive Predictive value of S/D Ratio : 30%

Chart 16 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR PREECLAMPSIA (POSITIVE PREDICTIVE VALUE)

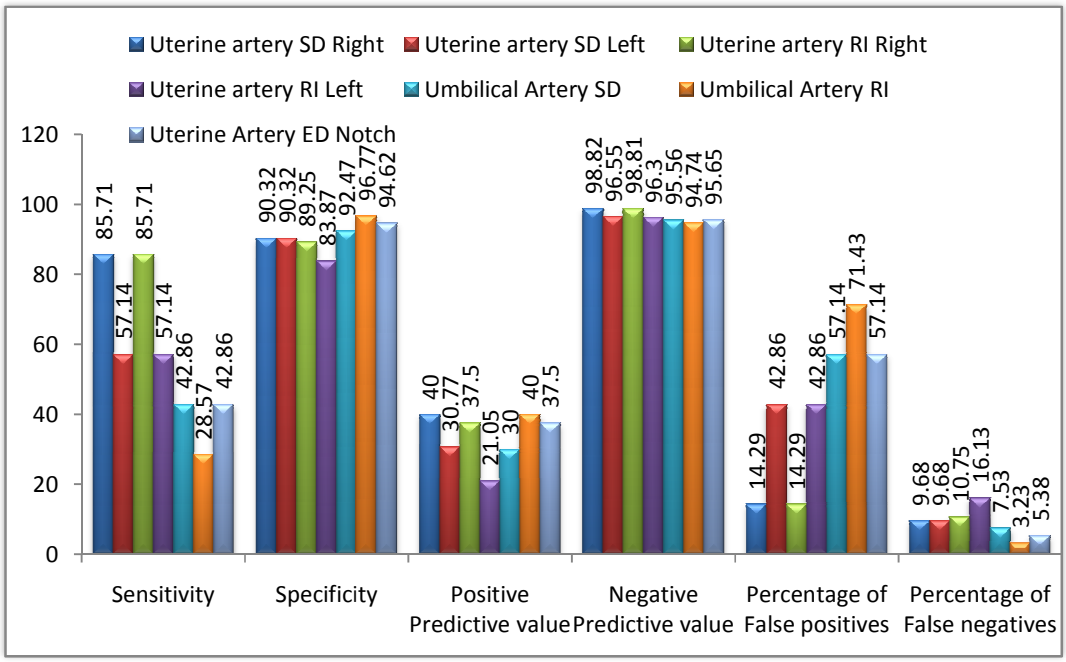


Table 22 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR IUGR (POSITIVE PREDICTIVE VALUE)

Parameter	Uterine Artery				Umblical Artery		Uterine artery ED notch
	SD		RI		SD	RI	
	Right	Left	Right	Left			
Sensitivity	53.85	38.46	53.85	38.46	69.23	7.69	30.77
Specificity	90.80	90.80	89.66	83.91	98.85	95.40	95.40
Positive Predictive value	46.67	38.46	43.75	26.32	90.00	20.00	50.00
Negative Predictive value	92.94	90.80	92.86	90.12	95.56	87.37	90.22
Percentage of False positives	46.15	61.54	46.15	61.54	30.77	92.31	69.23
Percentage of False negatives	9.20	9.20	10.34	16.09	1.15	4.60	4.60

Uterine artery Doppler indices

Sensitivity of S/D Ratio : Right 53.85%, Left 38.46%

Sensitivity of Notch : 30.77%

Positive Predictive value of S/D Ratio : Right 46.67%, Left 38.46%

Positive Predictive Value of Notch : 50.00%

Notch as a single parameter is the best predictor of IUGR but combination of parameter are best indicator.

Umblical Artery Doppler indices

Sensitivity of S/D Ratio : 69.23%

Positive Predictive value of S/D Ratio : 90%

Chart 17 : DISTRIBUTION OF VALIDITY PARAMETERS OF DOPPLER TEST FOR IUGR(POSITIVE PREDICTIVE VALUE)

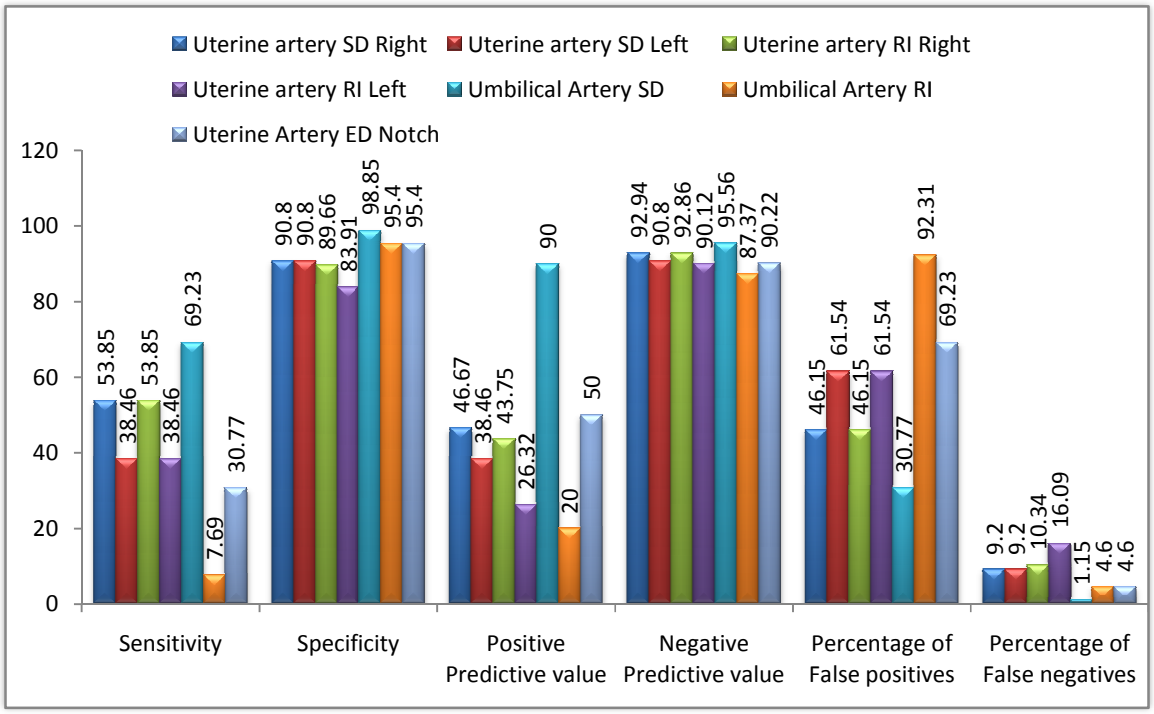


Table 23 : EFFECT OF BIO SOCIAL AND PHYSIOLOGICAL FACTORS OF THE STUDY POPULATION ON PREECLAMPSIA

Variable		Preeclampsia		Total	p-value
		No	Yes		
Parity	Primi gravida	82	7	89	1.000
	Multi gravida	11	0	11	
	Total	93	7	100	
SES	IV	19	0	19	0.341
	V	74	7	81	
	Total	93	7	100	
Albuminuria	Absent	93	0	93	0.000
	Present	0	7	7	
	Total	93	7	100	
Stay in NICU	No	80	2	82	0.002
	yes	13	5	18	
	Total	93	7	100	
Birth Weight	LBW	17	5	22	0.005
	Normal	76	2	78	
	Total	93	7	100	

p value < 0.05 = Significant,

0.00 = Highly Significant (HS),

> 0.05 = Not Significant (NS)

Parity : 1.00 (No Significance on Preeclampsia)

SES : 0.341 (NS)

Albuminuria : 0.00 (HS)

Stay in NICU : 0.002 (Significant)

Birth Weight : 0.005 (Significant)

Chart 18 : EFFECT OF BIO SOCIAL AND PHYSIOLOGICAL FACTORS OF THE STUDY POPULATION ON PREECLAMPSIA

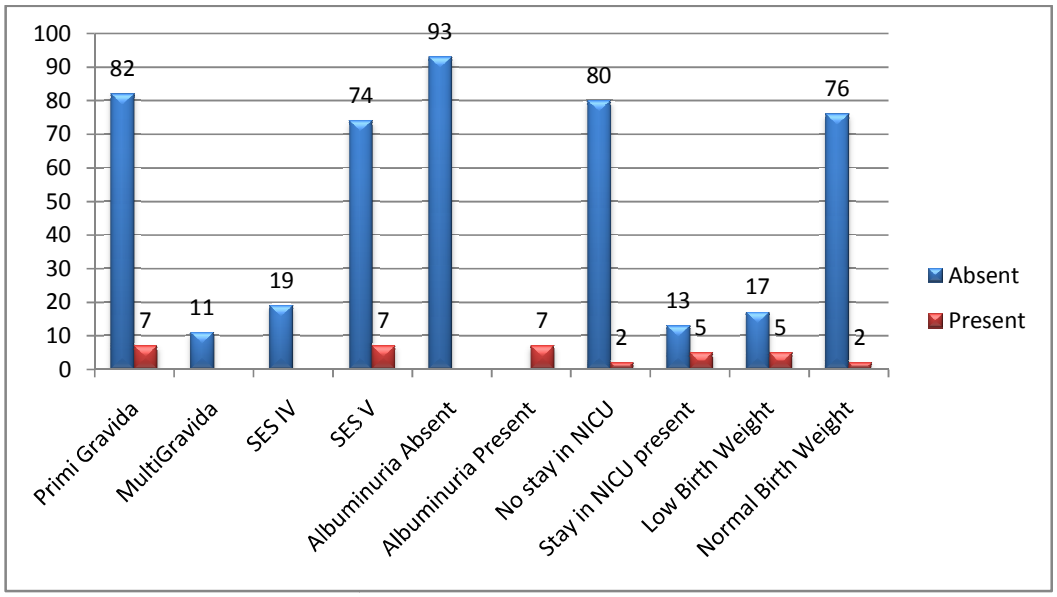


Table 24: EFFECT OF BIO SOCIAL AND PHYSIOLOGICAL FACTORS OF THE STUDY POPULATION ON IUGR

Variable		IUGR		Total	p-value
		No	Yes		
Parity	Primi gravida	76	13	89	0.350
	Multi gravida	11	0	11	
	Total	87	13	100	
SES	IV	19	0	19	0.121
	V	68	13	81	
	Total	87	13	100	
Albuminuria	Absent	86	7	93	0.000
	Present	1	6	7	
	Total	87	13	100	
STAY IN NICU	No	81	1	82	0.000
	yes	6	12	18	
	Total	87	13	100	
Birth Weight	LBW	11	11	22	0.000
	Normal	76	2	78	
	Total	87	13	100	

p value < 0.05 = Significant,

0.00 = Highly Significant (HS),

> 0.05 = Not Significant (NS)

Parity : 0.350 (No Significance on IUGR)

SES : 0.121 (NS)

Albuminuria : 0.00 (HS)

Stay in NICU : 0.000 (HS)

Birth Weight : 0.000 (HS)

Chart 19: EFFECT OF BIO SOCIAL AND PHYSIOLOGICAL FACTORS OF THE STUDY POPULATION ON IUGR

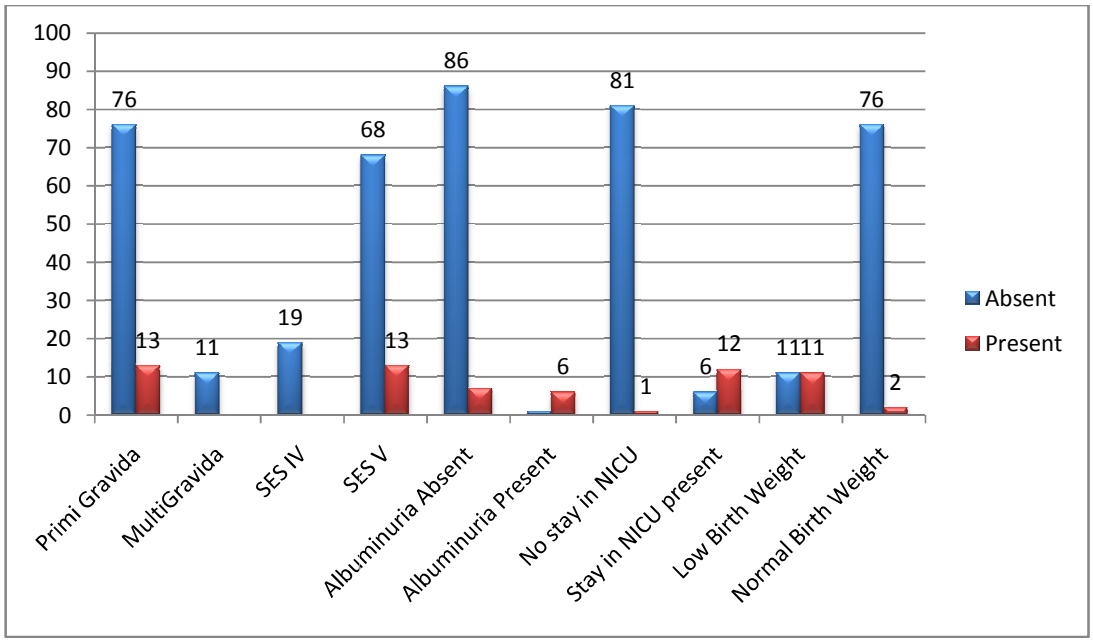


Table 25 : DISTRIBUTION OF VARIABLES ON PREECLAMPSIA .
(INDEPENDENT SAMPLE T TEST)

Variable	Preeclampsia	N	Mean	Std. Deviation	Sig. (2-tailed)	95% Confidence Interval of the Difference	
						Lower	Upper
Age	Present	7	23.8571	2.47848	.633	-1.84147	1.12565
	Absent	93	24.2151	1.86413			
Systolic BP	Present	7	151.4286	6.90066	.000	24.01455	39.74582
	Absent	93	119.5484	10.28773			
Diastolic BP	Present	7	101.4286	6.90066	.000	19.16424	31.64989
	Absent	93	76.0215	8.09452			
Gestational age	Present	7	26.8571	.89974	.948	-.54505	.58192
	Absent	93	26.8387	.71156			
Uterine Artery SD Right	Present	7	4.6586	1.55191	.000	2.18871	3.28047
	Absent	93	1.9240	.60634			
Uterine Artery SD Left	Present	7	3.7229	2.62194	.000	1.17904	2.50625
	Absent	93	1.8802	.57193			
Uterine Artery RI Right	Present	7	.7271	.15808	.000	.18447	.38739
	Absent	93	.4412	.12844			
Uterine Artery RI Left	Present	7	.6171	.28756	.011	.03865	.28988
	Absent	93	.4529	.14964			
Umbilical Artery SD	Present	7	4.8343	2.09154	.001	.71397	2.61159
	Absent	93	3.1715	1.14015			
Umbilical Artery RI	Present	7	.7071	.10029	.257	-.03079	.11377
	Absent	93	.6657	.09243			
Low Birth Weight	Present	7	2.0571	.55108	.000	-1.21942	-.40178
	Absent	93	2.8677	.52392			
APGAR	Present	7	5.71	3.988	.000	-4.019	-2.402
	Absent	93	8.92	.337			
Stay in NICU	Present	7	4.00	4.761	.013	.700	5.816
	Absent	93	.74	3.169			

Systolic BP, Diastolic BP, Uterine Artery SD Right, Uterine Artery SD Left , Uterine Artery RI Right, Uterine Artery RI Left, Umbilical Artery SD, Low Birth Weight, APGAR Stay in NICU these variables are significant .

Table 26 : Distribution of variables on IUGR. (Independent sample T test)

Variable	IUGR	N	Mean	Std. Deviation	Sig. (2-tailed)	95% Confidence Interval of the Difference	
						Lower	Upper
Age	Present	13	24.1538	2.23033	.942	-1.16839	1.08528
	Absent	87	24.1954	1.86048			
Systolic BP	Present	13	135.8462	18.96420	.000	9.19555	23.14044
	Absent	87	119.6782	10.43640			
Diastolic BP	Present	13	91.8462	12.63491	.000	10.95954	21.33047
	Absent	87	75.7011	8.10701			
Gestational age	Present	13	27.0769	.86232	.205	-.15169	.69634
	Absent	87	26.8046	.69615			
Uterine Artery SD Right	Present	13	3.2292	1.81126	.000	.75242	1.80811
	Absent	87	1.9490	.67385			
Uterine Artery SD Left	Present	13	2.8423	1.89288	.001	.41431	1.50088
	Absent	87	1.8847	.68266			
Uterine Artery RI Right	Present	13	.5915	.19979	.001	.06662	.23294
	Absent	87	.4418	.13062			
Uterine Artery RI Left	Present	13	.5492	.21403	.048	.00097	.19409
	Absent	87	.4517	.15532			
Umbilical Artery SD	Present	13	5.3231	1.47202	.000	1.73743	2.94114
	Absent	87	2.9838	.93974			
Umbilical Artery RI	Present	13	.7662	.06813	.000	.06176	.16259
	Absent	87	.6540	.08757			
Low Birth Weight	Present	13	2.0531	.40809	.000	-1.15561	-.58675
	Absent	87	2.9243	.49145			
APGAR	Present	13	6.85	3.158	.000	-2.788	-1.473
	Absent	87	8.98	.151			
Stay in NICU	Present	13	6.62	7.217	.000	4.966	8.012
	Absent	87	.13	.567			

Systolic BP, Diastolic BP, Uterine Artery SD Right, Uterine Artery SD Left, Uterine Artery RI Right, Uterine Artery RI Left, Umbilical Artery SD, Umbilical Artery RI, Low Birth Weight, APGAR, Stay in NICU these variables are significant for IUGR.

Table 27 : UTERINE AND UMBILICAL ARTERY DOPPLER AND THE OCCURRENCE OF PREECLAMPSIA

Variable			Preeclampsia		Total	p-value
			Yes	No		
Uterine Artery SD	Right	Abnormal	6	9	15	0.000
		Normal	1	84	85	
		Total	7	93	100	
	Left	Abnormal	4	9	13	0.005
		Normal	3	84	87	
		Total	7	93	100	
Uterine Artery RI	Right	Abnormal	6	10	16	0.000
		Normal	1	83	84	
		Total	7	93	100	
	Left	Abnormal	4	15	19	0.023
		Normal	3	78	81	
		Total	7	93	100	
Umbilical Artery SD		Abnormal	3	7	10	0.021
		Normal	4	86	90	
		Total	7	93	100	
Umbilical Artery RI		Abnormal	2	3	5	0.038
		Normal	5	90	95	
		Total	7	93	100	
Uterine Artery ED notch		Yes	3	5	8	0.010
		No	4	88	92	
		Total	7	93	100	

p value < 0.05 = Significant,

0.00 = Highly Significant (HS),

> 0.05 = Not Significant (NS)

Uterine Artery SD : Right = 0.000 (HS), Left = 0.005 (Significant)

Uterine Artery RI : Right = 0.000 (HS), Left – 0.023 (Significant)

Uterine Artery ED notch : 0.010 (Significant)

Umbilical Artery SD : 0.021 (Significant)

Umbilical Artery RI : 0.038 (Significant)

Table 28: UTERINE AND UMBILICAL ARTERY DOPPLER AND THE OCCURRENCE OF IUGR

Variable			IUGR		Total	p-value
			Yes	No		
Uterine Artery SD	Right	Abnormal	7	8	15	0.000
		Normal	6	79	85	
		Total	13	87	100	
	Left	Abnormal	5	8	13	0.012
		Normal	8	79	87	
		Total	13	87	100	
Uterine Artery RI	Right	Abnormal	7	9	16	0.001
		Normal	6	78	84	
		Total	13	87	100	
	Left	Abnormal	5	14	19	0.068
		Normal	8	73	81	
		Total	13	87	100	
Umbilical Artery SD		Abnormal	9	1	10	0.000
		Normal	4	86	90	
		Total	13	87	100	
Umbilical Artery RI		Abnormal	1	4	5	0.509
		Normal	12	83	95	
		Total	13	87	100	
Uterine Artery ED notch		Yes	4	4	8	0.009
		No	9	83	92	
		Total	13	87	100	

p value < 0.05 = Significant,

0.00 = Highly Significant (HS),

> 0.05 = Not Significant (NS)

Uterine Artery SD : Right = 0.000 (HS), Left = 0.012 (Significant)

Uterine Artery RI : Right = 0.001 (Significant), Left – 0.068 (Significant)

Uterine Artery ED notch : 0.009 (Significant)

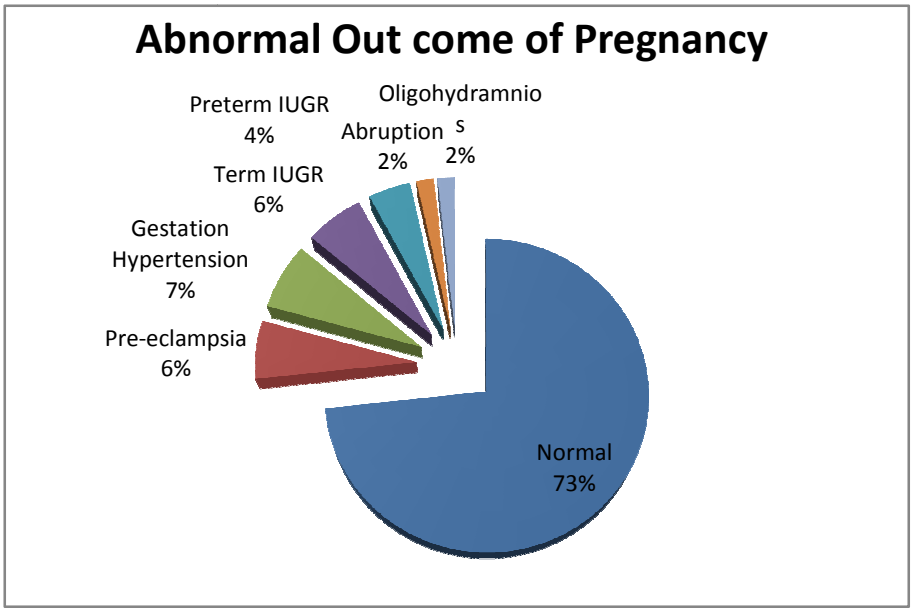
Umbilical Artery SD : 0.000 (HS)

Umbilical Artery RI : Not Significant

Table . 29 Abnormal Out come of Pregnancy

Pregnancy Events	No. of subjects	Percent
Normal	85	85.0
Pre-eclampsia	7	7.0
Gestation Hypertension	8	8.0
Term IUGR	7	7.0
Preterm IUGR	5	5.0
Abruption	2	2.0
Oligohydramnios	2	2.0

Chart : 20 Abnormal Out come of Pregnancy



DISCUSSION

DISCUSSION

In this prospective study conducted in Coimbatore medical college hospital for one year the outcomes of the study, the predictive values of various Doppler indices have been discussed.

INCIDENCE AND PREVALANCE

The incidence of hypertension is 15%, the incidence of Preeclampsia is 7%, the incidence of gestational hypertension is 8%, IUGR 13%.

The prevalence of Preeclampsia was 7% which was similar to that quoted by Bewley et al,[83] 1991 (4.6%) and Iron et al[86], 1998 (4%). Prevalence of SGA less than 10 percentile was 10%, similar to that quoted by North et at,[13] 1994 (6.6%).

AGE DISTRIBUTION

In this study most of the cases are between 21 to 25 years of age

PARITY

In our study most of the patients are primi gravida

SOCIOECONOMIC STATUS

81% belong to SES- V

PROTEINURIA

In 100 patients 7 had albuminuria

GA at the time of scan.

Mean GA - 26.84 wks.

Placental position 59% Centrally Located, 41% Unilateral

Type of delivery

Among 29 Patients of abnormal Doppler 25 Patients were induced

12 Patients had vaginal Delivery

13 Patients went for emergency LSCS

4 Patients Went for Elective LSCS

GA at the time of delivery :

Mean Gestational at the time of delivery age 38.62 weeks

Pre term 18%

Term 82%

Stay in NICU 18%

LBW 22%

IUGR 13 %

Term IUGR 7%

Pre Term IUGR 5%

UTERINE AND UMBLICAL ARTERY DOPPLER INDICES IN PREECLAMPSIA

Among the 100 patients studied there were 17 patients with abnormal uterine artery Doppler when 95th percentile was taken as cut off. Among them 15 Patients had abnormal Rt SD ratio, 13patients had abnormal Lt SD ratio, 16 patients had abnormal Rt RI, 17 patients had abnormal Lt RI, 8 patients had early diastolic notch.

There were 12 patients with abnormal umblical Doppler among them 10 patients had abnormal SD ratio, 5 had abnormal RI, 1 patients had absent diastolic flow, 1 patient had reverse end diastolic flow.

Sensitivity and specificity of abnormal uterine Doppler in Preeclampsia : Out of these 29 Patients with abnormal Doppler 7 patients developed Preeclampsia with a sensitivity of 85.71%,57.14%,85.71% ,57.14%, 42.86% for uterine S/D (Rt, Lt) ratio , RI (Rt&Lt) and notch respectively. This is similar to the result abtained by Kurdi et al[76]. The specificity was 90.32%, 90.32%, 89.25%, 83.87%, 94.62% for all the indicies. The positive predictive value was 40.00%, 30.77%, 37.50%,21.05%, for SD (Rt&Lt) ratio and RI (Rt &Lt), while it was 37.5% for notch. This indicates that notch is the better predictor of Preeclampsia . this is similar to opinions bt Bower et al[78]1993, Chan et al[96] 1995 and Antsaklis et al 2000[77].

Sensitivity and specificity of abnormal umblical artery Doppler in Preeclampsia : The sensitivity of 42.86%, 28.57% for SD ratio & RI respectively and with specificity of 92.47% to 96.77% for SD and RI respectively and 100% for absent diastolic flow. Positive predictive value of 30% for SD ratio, 40% for RI and 100% for diastolic flow. This indicates that umblical artery Doppler is more predictive than uterine artery Doppler.

UTERINE AND UMBLICAL ARTERY DOPPLER INDICES IN IUGR

There were 13 patients with birth weight less than 10 precentile. In uterine artery Doppler the sensitivity of 53.85%, 38.46%, 53.85%, 38.46% and 30.77% for SD(rt,lt), RI(rt,lt) and notch respectively. It is similar to opinion by Irion et al[86] North et al[13]and Bower et al[78]. The specificity was 90.80%, 90.80%, 89.66%, 83.91% , 95.40% for all the indices. The positive predictive value of notch was 50% which is greater than the other indices. SD ratio has the highest specificity in IUGR.

The umblical artery Doppler indices in IUGR- the sensitivity of 69.23%.7.69% for both SD and RI. It is similar to opinion by Atkinson et al[89] and Beattie Dorman et al[87] Sensitivity of absent diastolic flow was 100% because only one patient was having AEDF that patient developed Preeclampsia and abruption and delivered an IUD hence giving the sensitivity of 100 %. Sensitivity of REDF 100% that patient developed Preeclampsia.

The specificity is 98.85%, 95.40%, for SD and RI. The positive predictive value for SD and RI are 90% , 20%

Table 30 : COMPARISON OF STUDY AT CMCH WITH PREVIOUS STUDIES ON UTERINE ARTERY DOPPLER FOR PREECLAMPSIA

Author	Outcome measure	Indicator	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Bewley et al., 1991	Pre eclampsia	RI>95th Centile	4.6	24	95	20	96
Bower et al., 1993	Pre eclampsia	RI>95th centile +/-notch	2.5	7.5	86	12	99
North et al., 1994	Pre eclampsia	RI>90th Centile	3.3	27	89	8	97
Chan et al., 1995	Pre eclampsia	RI>95th Centile	6.9	22	97	36	94
Irion et., al 1998	Pre eclampsia	SD>90th centile +notch	4	26	88	7	
Kurdi et al., 1988	Pre eclampsia	RI>95th > Centile	2.2	62	89	11	99
Present Study at CMCH	Pre eclampsia	RI> 95th Centile	7	85.71	89.25	37.50	98.81
Present Study at CMCH	Pre eclampsia	Notch	7	42.86	94.62	37.50	95.65

Results are similar to the other studies except notch is more predictive, RI is also having more predicative value as the present study was done from 26 weeks which reduces false positive rate.

Table 31.Comparison of study at CMCH with previous studies for IUGR with uterine artery Doppler

Author	Outcome measure	Indicator	Prevalence (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Bewley et al., 1991	IUGR<10th Centile	RI>95th Centile	12.9	15	96	35	88
Bower et al., 1993	IUGR<10th Centile	RI>9th Centile	10.9	37.5	86.6	25.5	91.8
North et al., 1994	IUGR<10th Centile	RI>95th Centile	6.6	47	91	27	96
Irion et al 1998	IUGR<10th Centile	RI>90th Centile	11	29	89	25	
Irion et al 1998	IUGR<10th Centile	Notch	11	30	88	24	
Present Study at CMCH	IUGR<10th Centile	RI> 95th Centile	11	53.85	89.66	43.75	92.86
Present Study at CMCH	IUGR<10th Centile	Notch	11	30.77	95.40	50.00	90.22

Results are similar to other studies but positive predictive value for notch is more as the present study done from 26 weeks of gestation, which reduces false positive rate.

Table 32.Comparison of study at CMCH with previous studies for IUGR with umbilical artery doppler

Author	Out come measure	Indicator	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Atkinson et al 1994	IUGR<10th Centile	S/D ratio	18	91	13	94
Beattie and Dorman et al 1989	IUGR<10th Centile	S/D ratio	40	84		
Present Study at CMCH	IUGR<10th Centile	S/D ratio	69.23	98.85	20.00	87.37

Sensitivity and specificity of present study is similar to Atkinson et al study

CONCLUSION

CONCLUSION

- Combination of Doppler indices of uterine and umblical artery is the best indicator for prediction of Preeclampsia and IUGR.
- Diastolic notch in the uterine artery as a single parameter is better than the individual Doppler indices in uterine artery.
- Absent diastolic flow in umblical artery is better predictor of Preeclampsia, fetal growth restriction and poor prenatal outcome.
- Uterine and umblical artery Doppler may be included in hospitals with facilities and infra structure to identify a group of patients at a risk of developing Preeclampsia or fetal growth restriction.
- Combined uterine artery and umblical artery Doppler is the best predictor for Preeclampsia and IUGR

SUMMARY

SUMMARY

In this study a total of 105 patients were studied from Coimbatore Medical college Hospital. 5 patients were excluded from the study as they did not deliver at CMCH. Analysis was done for 100 cases.

Uterine and umblical artery Doppler were studied in all 100 cases.

The outcome studied are preeclampsia, IUGR statistical analysis was carried out using sensitivity specificity and predictive values.

- In this study most of the women were in the age group 21-26 years
- The incidence of primi gravida in the study population is 82%
- Mean gestational age at which scan was 26.84 weeks.
- Mean gestational at the time of delivery 38.62 weeks.
- The incidence of Albuminuria 7 (7%)
- The incidence of IUGR is 13% - Term IUGR 7 %, pre term IUGR 5%
- Preterm 18% (18 babies) in that 5 were preterm IUGR.
- When uterine artery Doppler was abnormal (17 patients), there were 6 patients with pre-eclampsia. 7 patients with IUGR. With sensitivity of 86% and specificity of 90% for pre eclampsia 54% and 90% for IUGR.
- When Umbilical artery Doppler was abnormal in 12 patients 10 patients developed preeclampsia and 4 developed IUGR with sensitivity and specificity of 43% and 93% for preeclampsia. 70% and 98.85% for IUGR.

- 29 cases (29%) had abnormal doppler indices – abnormal umblical & uterine doppler - 12% & 17% - 7 (7%) had preeclampsia, 8 (8%) had GHT, 13 (13%) IUGR the remaining showed normal indices.
- Among abnormal 29 cases 25 were induced for labour. 12 patients delivered by vaginally, 13 by emergency LSCS, 4 elective LSCS.
- NICU stay - Total babies 18 (18%) had NICU stay among that 10 babies of abnormal doppler had NICU stay and 8 babies of normal cases had NICU stay.
- LBW babies – Total 22 (22%) among these 12 (12%) are due to abnormal indices and 10 babies are due to normal cases.
- 1 patient had AEDF, 1 patient had REDF, they had abrution at 32 weeks and delivered an IUD baby accounting for 100% perinatal mortality in both AEDF & REDF.
- There were 2 IUD in abnormal umblical doppler indices due abruption.
- When both uterine and umblical artery doppler were abnormal for 4 patients all the 4 had preeclampsia and IUGR with 100% sensitivity and specificity.
- **Uterine and umblical Doppler can be used as a combined parameter in Predicting Preeclampsia Since it is more significant.**
- In Predicting IUGR also uterine artery Doppler indices- S/D Ratio, RI, ED Notch is significant, but in umbilical artery - S/D ratio, AEDF & REDF are only significant but as a single parameter,

Umbilical Artery RI : Not Significant

Thus uterine and umbilical artery Doppler can be used predictor for the development of IUGR

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ANNEXURES

PROFORMA

PROFORMA

DOPPLER STUDY ON UTERINE AND UMBILICAL ARTERY TO PREDICT

PIH AND IUGR

Serial No. :

I.P /O.P.NO :

Name :

D.O.A :

AGE :

D.O.D :

Husband's Name :

Date of Delivery :

Occupation

Educational Status :

Socio-Economic Status :

PRESENTING COMPLAINT

OBSTETRIC HISTORY :

GPLA, Con/Non-Consanguinence Marriage

Present Obstetric history :

Booked /Unbooked

LMP :

Period of Amenorrhoea

EDD :

Corrected EDD :

Spontaneous Conception Induced

I Trimester Details

II Trimester Details

III Trimester Details

Past Obstetric History :

Complication during past pregnancy and delivery: like PIH / GDM

Mode of delivery :

Normal Vaginal delivery

Instrumental

LSCS

Outcome of past delivery: Weight of baby, Term, Preterm, IUGR, Stillborn,

Living, Dead Neonata Problem : Congenital anamoly, Birth

Asphyxia, Jaundice, Sepsis Menstrual History : Cycle regular / Irregular

PAST HISTORY

History of DM, HTN, TB, RHD, Renal Disease, Rickets, BT, Allergy to drug, Asthma Epilepsy

Surgical History – Any previous surgeries

FAMILY HISTORY

DM, HTN, TB, Epilepsy, Asthma, Multiple Pregnancy, Congenital Anamolies unexplained Fetal / Neonatal Death.

GPE
PALLOR/ICTERUS / CYANOSIS / CLUBBING /
LYMPHADENOPATHY / OEDEMA

SYSTEMIC EXAM'S

PR-	:	CVS	:	Thyroid
Temp	:	RS	:	BREAST
BP	:			Height
RR	:			Weight

Sl.No.	Date	Wt.	Oedem	BP	P/A	Liquo	FHR	P/V

INVESTIGATIONS

1. Routine

HB% : HIV : Urine Routine:

Blood Grouping & Typing: HBSag : BT :

RBS : VDRL : CT :

2. Ultrasound
Gestational age :

Fetal Biometry : BPD : AC :

FL : EFW : HC : AFI :

Congenital Anamolies :

Placental grading :

3. Doppler Report

Doppler Velocity Values in uterine artery

	SD Ratio	RI	Presence or Absence of
Left Uterine			
Right			

Doppler Velocity Values in Umbilical artery

	SD Ratoo	RI	Presence or Absence of	Presence or Absence of Absent Reverse
Umbalical				

DELIVERY DETAILS:

Intranatal Course :

I Stage : II

Stager :

Mode of Delivery : NVD

Instrumental : Forceps Vaccum

LSCS – Indication for LSCS

Induction of Labour – ROM, Oxytocin drip, Dinoprostone Gel, Misoprostol

Outcome of labour and delivery:

Sex of Baby

Apgar 1' 5'

Term

Preterm

Age Assessment

Baby weight

Meconium Stained Thin

Thick

Neonatal Complications:-

Live Birth

Still Birth

Birth Asphyxia

Jaundice

Sepsis

Congenital anamoly

Neonatal death

IUGR/Symmetrical/Asymmetrical

Ventilatory Support

NICU stay

Any others

CONSENT FORM

INFORMED CONSENT

DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY

Coimbatore Medical College, Coimbatore

Principal investigator : Dr. Nithya.R

Research guide : Dr. Manonmani.

Organisation : Department of Obstetrics and Gynaecology

Informed consent : I have been invited to participate in research project titled **STUDY OF DOPPLER STUDY ON UTERINE AND UMBLICAL ARTERY TO PREDICT PREECLAMPSIA AND IUGR**

I understand, it will be answering a set of questionnaire, undergo physical examination, investigations and appropriate treatment.

I also give consent to utilise my personal details for study purpose and can be contacted if necessary.

I am aware that I have the right to withdraw at any time which will not affect my medical care.

Name of the participant :

Signature :

Date :

MASTER CHART

MASTER CHART

S.No	Name	Op.No	age	parity	SES	BP	U/A	GA at During scan	UTERINE ARTERY DOPPLER					UMBLICAL ARTERY DOPPLER				PREECLAMPSIA	IUGR	BWT	GA at the time of delivery	APG	STAY IN NICU	
									RTS/D	LTS/D	RT RI	LT RI	E.D Notch	S/D	RI	AEDF	REDF							
1	surya	24654	24	p	V	120/80	NIL	26	1.89	1.33	0.47	0.248		2.62	0.618	-	-			3.6	39	9		
2	sahar banu	24564	23	p	V	110/70	NIL	26	1.7	1.4	0.4	0.32		1.54	0.7	-	-			3	39	8		
3	kalaivani	25467	22	G2P1L1	V	110/70	NIL	27	1.6	1.4	0.37	0.31		1.3	0.77	-	-			3	39	9		
4	Ranjitha devi	25675	20	P	IV	100/70	NIL	26	1.55	1.67	0.33	0.38		3.39	0.7	-	-			2.75	39	9		
5	Banu priya	25432	22	P	V	100/80	NIL	28	1.6	1.47	0.36	0.31		1.3	0.75	-	-			2.85	39	9		
6	Thanga lakshmi	25347	23	P	V	110/70	NIL	26	1.6	2.5	0.3	0.6		1.51	0.7	-	-			2.4	39	9	1	
7	Subbu lakshmi	25436	20	P	IV	120/80	NIL	27	2.24	1.91	0.55	0.47		3.79	0.77	-	-			2.75	39	9	3	
8	kasthuri	25352	21	P	V	**150/110**	**1+**	27	**4.82**	**8.39**	**0.79**	**0.98**	+	**7.6**	**0.78**	-	+	+	+	**1.45**	**32**	**0**		
9	Naga jothi	25774	23	P	V	130/80	NIL	28	1.25	1.65	0.39	0.2		**3.2**	0.58	-	-			4.2	39	9	1	
10	Fathima beebi	25667	20	P	V	**160/100**	**2+**	26	**6.2**	**1.1**	**0.8**	0.1		2.7	0.6	-	-	+	+	1.5	36	8	7	
11	kalpana	26446	21	G2P1L1	V	120/80	NIL	27	1.86	2.3	0.46	0.56		4.7	0.77	-	-			3	39	9		
12	Ramya	26557	23	P	V	110/70	NIL	28	1.65	2	0.45	0.5		**4.67**	**0.8**	-	-		+	**2.8**	**38**	**9**	**1**	
13	Jeya lakshmi	26456	24	P	IV	120/70	NIL	28	1.6	1.1	0.3	0.1		3.3	0.7	-	-			2.55	40	9		
14	Hema	27543	25	P	V	110/84	NIL	28	2.2	2.1	0.545	0.53		2.32	0.56	-	-			2.75	39	9		
15	kamalaveni	27668	26	P	V	**130/90**	NIL	26	2.19	1.3	0.542	**0.77**		4.52	0.77	-	-			3.2	39	9		
16	Bharathi	27654	22	P	IV	110/68	NIL	27	1.74	2	0.42	0.49		3.67	0.72	-	-			2.95	39	9		
17	geetha	27744	24	P	V	**150/90**	NIL	27	2.24	1.78	0.55	0.43		1.07	0.6	-	-			2.8	40	9		
18	Nagalakshmi	28742	24	P	IV	116/70	NIL	27	1.79	1.08	0.438	0.99		2.42	0.56	-	-			2.5	40	9		
19	pavithra	28744	23	G2P1L1	V	124/68	NIL	27	1.23	1.38	0.18	0.27		2.38	0.57	-	-			2.75	40	9		
20	sridevi	28777	25	P	V	110/78	NIL	28	1.71	1.87	0.43	0.46		**4.69**	**0.78**	-	-		+	**2.25**	**40**	**9**	**20**	
21	shanthi	28744	24	P	V	118/76	NIL	27	1.29	1.79	0.22	0.44		2.93	0.65	-	-			3.45	38	9		
22	Angel	28765	30	P	V	**140/100**	NIL	26	**2.8**	**3.36**	**0.6**	**0.7**		2.54	0.506	-	-			2.8	39	9		
23	Saranyadevi	28578	24	P	V	**150/100**	**2+**	28	1.61	2.19	0.37	0.54		**6.74**	**0.77**	+	-	+	+	1.5	32	0		
24	kavitha	28657	24	P	V	130/90	NIL	27	**3.07**	**3.85**	**0.74**	**0.67**	+	3.95	0.74	-	-		+	**1.7**	**36**	**7**	**22**	
25	Marumalar selvi	28785	26	P	V	104/70	NIL	26	1.22	1.55	0.17	0.35		3.23	0.69	-	-			3	39	9		

26	Ambika	28873	25	P	V	130/74	NIL	26	1.62	1.4	0.38	0.28		2.7	0.63	-	-			3.25	38	9		
27	Rajakumari	28966	24	P	V	120/68	NIL	27	2.21	1.91	0.54	0.44		3.94	0.74	-	-			3.3	39	9		
28	sowmiya	29303	23	P	IV	132/76	NIL	28	1.51	2.11	0.34	0.52		4.18	0.76	-	-			2.7	38	9		
29	simbal	28734	23	P	V	120/70	NIL	26	2.13	1.71	0.53	0.41		4	0.75	-	-			2.65	39	9	1	
30	priyanka	29334	21	P	V	100/76	NIL	27	1.87	1.9	0.47	0.46		2.37	0.57	-	-			2.45	40	9		
31	prema	29463	25	G2P1L1	V	110/78	NIL	27	1.74	1.66	0.42	0.39		4.19	0.76	-	-			3.75	39	9		
32	selvi	29465	23	P	V	132/74	NIL	28	2.05	1.91	0.51	0.47		2.39	0.5	-	-			2.5	39	9		
33	vijayalakshmi	29485	25	P	V	120/70	NIL	26	1.8	1.7	0.4	0.4		2.58	0.61	-	-			2.4	40	9		
34	sabitha	29606	24	P	V	120/80	NIL	27	2.37	1.75	0.55	0.44		3.17	0.68	-	-			3	39	9		
35	boomadevi	29631	24	P	V	118/80	NIL	27	1.96	1.8	0.48	0.44		2.63	0.62	-	-			2.65	38	9		
36	Banu	29647	25	P	V	**150/100**	**1+**	26	**6.2**	**3**	**0.8**	**0.7**		**4.9**	**0.71**	-	-	+	+	1.7	36	6	13	
37	devi	29692	21	P	V	120/70	NIL	27	2.12	2.06	0.52	0.51		2.79	0.64	-	-			3.15	39	9		
38	Eswari	29690	22	P	IV	120/70	NIL	28	1.55	1.97	0.35	0.49		**4.83**	**0.77**	-	-			2.5	38	9		
39	Devi	29466	25	P	V	**140/100**	NIL	28	**5.2**	**2.68**	**0.8**	**0.57**		3.41	0.7	-	-			3.4	40	9		
40	Anitha	29706	25	G2P1L1	V	112/68	NIL	26	1.6	1.6	0.37	0.37		2.6	0.6	-	-			3.35	38	9	1	
41	semina	29654	27	P	V	100/64	NIL	26	1.5	1.66	0.33	0.39		4.08	0.75	-	-			3.1	39	9		
42	Sameena	29388	23	P	V	**130/90**	NIL	27	**2.88**	2.43	**0.65**	**0.59**		2.78	0.63	-	-			2.7	39	9		
43	kaleeshwari	29484	25	P	V	110/76	NIL	27	2.14	2.06	0.53	0.57		2.38	0.5	-	-			4.2	38	9		
44	sumathi	29562	26	P	V	110/70	NIL	27	1.71	2.17	0.41	0.54		1.54	0.7	-	-			1.5	37	9		
45	Thangaselvi	29452	26	P	V	**150/90**	NIL	26	**3.13**	**4.07**	**0.68**	**0.75**	+	**6.33**	**0.84**	-	-		+	**2.3**	**38**	**8**	**4**	
46	Sunitha	28833	23	P	V	**140/100**	NIL	26	**2.69**	**3.32**	**0.63**	**0.73**	+	3.49	0.71	-	-			3	39	9		
47	nandeswari	29594	23	P	IV	120/80	NIL	26	2.14	1.93	0.53	0.48		1.3	0.77	-	-			2.55	38	9		
48	ramya	27974	24	P	V	120/70	NIL	26	1.56	1.72	0.35	0.41		3.2	0.58	-	-			2.8	39	9		
49	suganthi	29580	24	P	IV	130/70	NIL	27	1.91	1.7	0.47	0.32		2.7	0.6	-	-			2.75	40	9		
50	chitra	29536	23	G3P2L1	V	120/70	NIL	27	1.93	1.67	0.48	0.38		2.05	0.51	-	-			2.25	39	9		

51	dhanalakshmi	29607	24	P	IV	114/64	NIL	27	1.83	1.53	0.45	0.35		2.31	0.56	-	-			3.45	39	9		
52	sajitha	29605	23	P	IV	112/70	NIL	27	1.38	1.44	0.3	0.32		2.42	0.56	-	-			2.8	39	9		
53	maheshwari	27753	25	P	V	124/76	NIL	28	2	1.89	0.5	0.47		2.05	0.51	-	-			3.1	40	9		
54	priya	29453	29	P	V	124/80	NIL	28	1.53	1.82	0.35	0.45		**5.2**	**0.81**	-	-		+	1.7	37	9	5	
55	ilakkiya	30050	27	P	V	118/76	NIL	26	2.22	1.65	0.58	0.39		2.93	0.65	-	-			3	38	9		
56	Archana	29583	26	G2P1L1	V	120/70	NIL	27	1.74	1.61	0.42	0.37		4	0.75	-	-			3.25	38	9		
57	priya	30222	24	P	V	130/70	NIL	28	2.16	1.32	0.56	0.28		4.18	0.76	-	-			3.3	39	9		
58	malathi	30336	25	P	V	120/76	NIL	27	1.98	1.62	0.5	0.38		3.94	0.74	-	-			3.75	40	9		
59	vijaya	29561	23	P	V	112/86	NIL	26	1.42	1.62	0.31	0.38		**6.74**	**0.77**	-	-		+	2.24	38	9	2	
60	kala	34434	22	P	V	128/80	NIL	27	1.64	1.41	0.38	0.31		2.93	0.65	-	-			2.45	39	9		
61	nithya	30379	26	P	V	110/60	NIL	27	1.86	1.65	0.46	0.39		2.42	0.56	-	-			3.7	38	9		
62	muthukumari	30418	25	P	V	120/80	NIL	26	1.71	1.87	0.43	0.46		2.05	0.51	-	-			2.5	39	9		
63	fathima	30662	26	G3P2L1	V	118/78	NIL	27	**3.07**	**3.85**	**0.74**	**0.67**	+	3.3	0.7	-	-			3.45	38	9		
64	ramalakshmi	30419	24	P	V	120/80	NIL	27	1.72	1.87	0.43	0.46		**6.28**	**0.83**	-	-		+	2.25	39	7	4	
65	kaliammal	30394	26	P	V	120/80	NIL	28	1.29	1.79	0.22	0.44		4.52	0.77	-	-			3.1	38	9		
66	senbagavalli	29993	27	P	IV	120/70	NIL	27	2.5	**3.36**	0.5	**0.7**		3.67	0.72	-	-			2.8	39	9		
67	musthira	29653	25		V	120/80	NIL	26	1.61	2.19	0.37	0.54		1.07	0.6	-	-			3.3	40	9		
68	kowsalya	29828	27	P	V	**150/90**	**1+**	26	**4.86**	**6.21**	**0.79**	**0.85**	+	2.42	0.56	-	-	+		2.95	40	9		
69	saraswathy	30453	27	P	V	110/70	NIL	26	1.22	1.55	0.17	0.35		2.38	0.57	-	-			2.4	39	9		
70	vasanthi	30408	25	P	V	120/86	NIL	26	1.62	1.4	0.38	0.28		4.69	0.78	-	-			3	38	9		
71	uma	30361	23	P	IV	114/68	NIL	26	2.21	1.91	0.54	0.44		2.93	0.65	-	-			3.75	38	9		
72	selvi	29465	24	P	V	124/76	NIL	26	1.51	2.11	0.34	0.52		2.54	0.506	-	-			2.6	37	9		
73	Saranyadevi	30341	24	P	IV	120/68	NIL	26	2.13	1.71	0.53	0.41		2.7	0.63	-	-			1.5	36	9		
74	sabira	30286	25	P	V	**140/100**	**1+**	27	**4.82**	1.9	**0.78**	0.46		**6.25**	**0.84**	-	-	+	+	**2.2**	**37**	**7**	**5**	
75	hemalatha	30369	24	G2P1L1	V	128/68	NIL	27	1.74	1.66	0.42	0.39		4	0.75	-	-			2.25	38	9		

76	jeevitha	30472	23	P	V	120/78	NIL	28	1.5	1.66	0.33	0.39		2.37	0.57	-	-			2.75	39	9		
77	chitra	30198	25	P	V	110/78	NIL	26	1.6	1.6	0.37	0.37		4.18	0.76	-	-			2.4	39	9		
78	thangamani	29761	25	P	IV	100/68	NIL	27	1.69	1.74	0.41	0.42		4	0.75	-	-			2.6	39	9		
79	amsaveni	30322	26	P	V	120/76	NIL	27	1.89	1.77	0.47	0.43		3.67	0.72	-	-			2.65	39	9		
80	bhuvaneshwari	31310	26	P	V	116/78	NIL	27	1.99	1.53	0.5	0.35		2.42	0.56	-	-			2.76	38	9		
81	radhika	31271	22	P	V	120/76	NIL	27	1.47	2.16	0.33	0.56		2.38	0.57	-	-			3.2	39	9		
82	geetha	29467	23	P	V	112/70	NIL	27	1.53	1.71	0.35	0.41		3.23	0.69	-	-			3.5	39	9		
83	maragatham	30872	26	P	IV	112/64	NIL	28	1.23	1.38	0.18	0.27		2.7	0.63	-	-			2.75	39	9		
84	nasiya	31140	25	P	V	124/76	NIL	26	1.29	1.79	0.22	0.44		4.18	0.76	-	-			**2.25**	**37**	8	**4**	
85	vidhya	31145	27	P	V	110/84	NIL	27	1.74	1.66	0.42	0.39		2.54	0.506	-	-			3.25	38	9		
86	kalpana	28932	27	P	IV	120/64	NIL	27	1.79	1.08	0.438	0.99		3.94	0.74	-	-			3.8	39	9		
87	chinnamal	30377	24	P	V	**150/90**	NIL	26	**3.31**	**2.89**	**0.7**	**0.63**		2.93	0.65	-	-			2.6	39	9		
88	pradeepa	31142	23	P	V	120/70	NIL	26	2.37	1.75	0.55	0.44		2.38	0.57	-	-			2.8	38	9		
89	anusiya	31124	22	P	V	120/80	NIL	27	1.96	1.8	0.48	0.44		4	0.75	-	-			3.8	40	9		
90	latha	31171	21	G2P1L1	V	112/80	NIL	26	1.53	1.82	0.35	0.44		1.07	0.6	-	-			2.5	39	9		
91	malika	31177	24	P	IV	120/76	NIL	27	1.74	1.81	0.42	0.44		2.42	0.56	-	-			2.6	39	9		
92	revathy	31897	26	P	V	**140/90**	NIL	27	**4.05**	**2.89**	**0.75**	**0.86**	+	2.39	0.5	-	-			3.1	39	9		
93	abirami	31781	27	P	V	120/80	NIL	26	1.41	1.65	0.31	0.39		4.9	0.71	-	-			2.75	37	9		
94	anandhi	31783	24	P	V	120/76	NIL	27	1.68	1.56	0.4	0.36		2.79	0.64	-	-			3.25	38	9		
95	murugathal	32003	22	P	V	120/80	NIL	28	2.5	1.8	0.5	0.44		2.6	0.6	-	-			2.7	38	9		
96	rasiya	31992	25	P	V	**160/110**	**1+**	28	**4.1**	**3.27**	**0.76**	**0.69**	+	3.23	0.69	-	-	+	+	**2.5**	**36**	**9**	2	
97	mercy	31964	23	G2P1L1	V	120/76	NIL	27	1.89	1.65	0.47	0.39		3.94	0.74	-	-			3.7	39	9		
98	nirmala	31081	26	P	V	120/70	NIL	27	1.83	1.47	0.45	0.33		4.18	0.76	-	-			2.8	39	9		
99	kokila	32002	27	P	IV	120/70	NIL	27	1.53	1.62	0.35	0.38		2.63	0.62	-	-			2.6	40	9		
100	radha	31968	22	P	V	110/70	NIL	26	1.91	1.56	0.47	0.36		3.17	0.68	-	-			2.7	39	9		

KEY AND ABBREVIATIONS TO MASTER CHART

KEY WORDS TO MASTER CHART

S.No	-	Serial Number
O.P. No	-	Out Patient Number
P	-	Primi
G	-	Gravida
SES	-	Socio Economic Status
BP	-	Blood Pressure
U/A	-	Urine Albumin
GA	-	Gestational Age
RT	-	Right
LT	-	Left
S/D	-	Systolic/ Diastolic ratio
RI	-	Resistance Index
ED notch	-	Early diastolic notch
AEDF	-	Absent end diastolic flow
REDF	-	Reverse end diastolic flow
IUGR	-	Intra Uterine Growth Restriction
APG	-	APGAR
NICU	-	Neonatal intensive care unit
+	-	Present
-	-	Absent